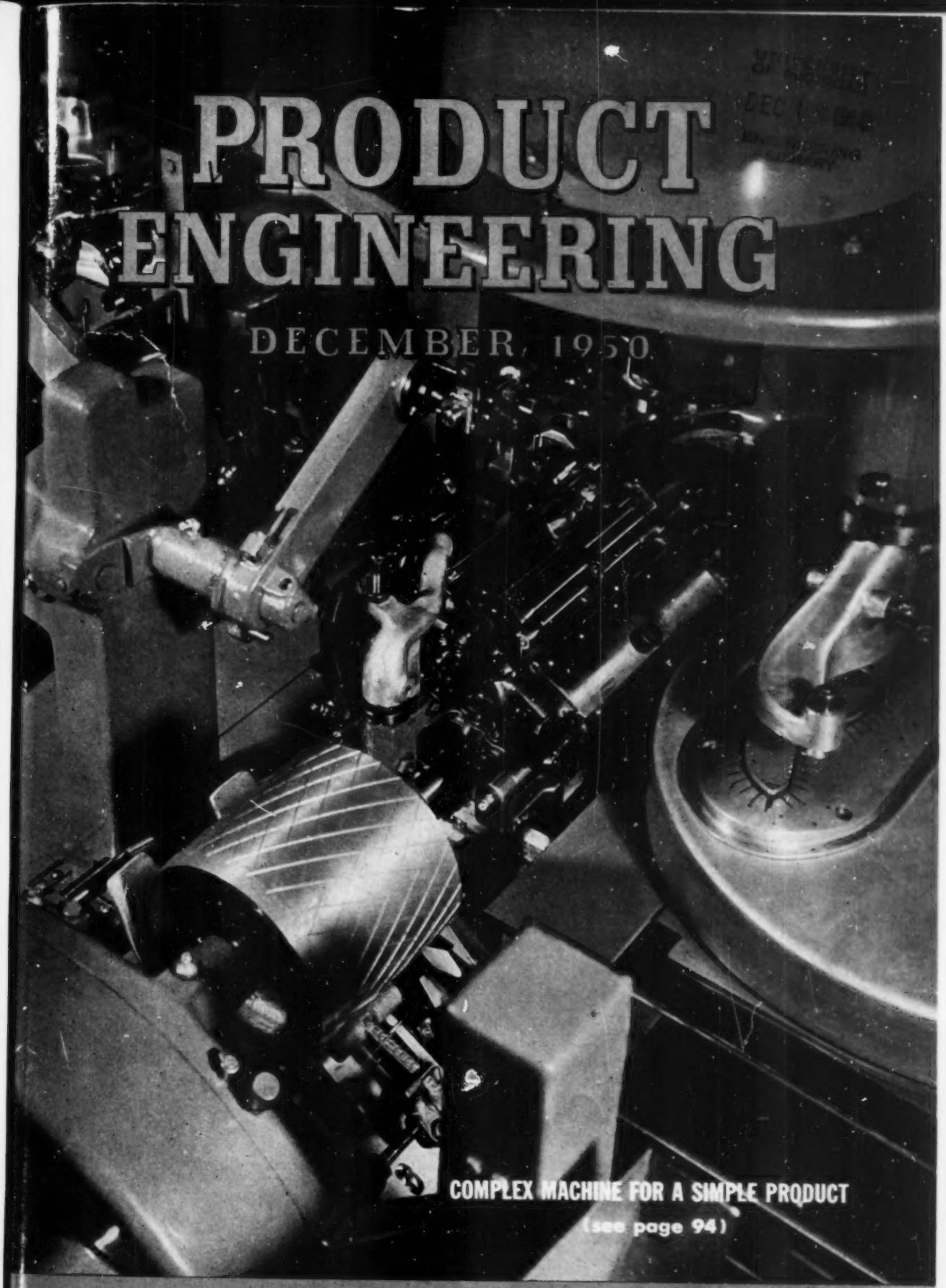
PRODUCT ENGINEERING

DECEMBER, 1950



COMPLEX MACHINE FOR A SIMPLE PRODUCT

(see page 94)

IN THIS ISSUE—Better Ways of Identifying Your Product + Critical Speed of Overhung Shafts + Cold Drawn Pinions + High-Speed Pneumatic Circuits

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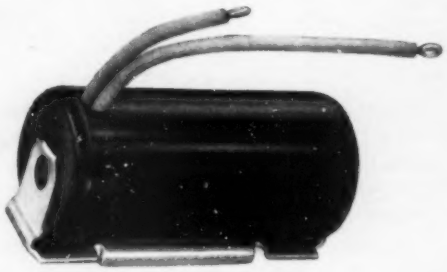

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THERE ARE TWO KINDS OF MISTAKES, stupid errors and wholesome misunderstandings. He who errs because of a reasonable misunderstanding is usually excused, but he who makes a stupid mistake is often held up to ridicule. Hence the fear of ridicule has often served as an unsurmountable barrier to an individual's progress. He refuses to attempt a new creation in order to avoid the penalty of possible errors. Or facing a vexing problem he labors with his mind in confusion, fearing to take a step toward the solution of his problem lest he make a mistake. That in itself is a mistake.

As Sir Francis Bacon put it, "*Citius emergit veritas ex errore quam ex confusione*". In engineering English this simply means that truth emerges more quickly out of error than out of confusion. This statement can hardly be open to argument because nothing but confusion ever comes out of a confused mind.

The discovery of America by Columbus is hailed as the greatest event of the fifteenth century. But as a matter of fact it was all a great mistake because Columbus thought it was India. And as Mark Twain pointed out, the discovery of America was not wonderful because it would have been a more wonderful feat had Columbus succeeded in missing it.

Confusion of mind is a mental state in which the mind cannot operate coherently and cannot discriminate or weigh facts. It is a completely disorderly and common state of mind. It is the kind of thinking one often does when trying to go to sleep.

To bring order out of confusion of thought, it is necessary to take a definite step toward the rationalization of the problem and a method for its solution. This may take the form of writing out the problem, listing a number of possible methods of solving it, trying several possibilities, or perhaps just guessing and then working backwards.

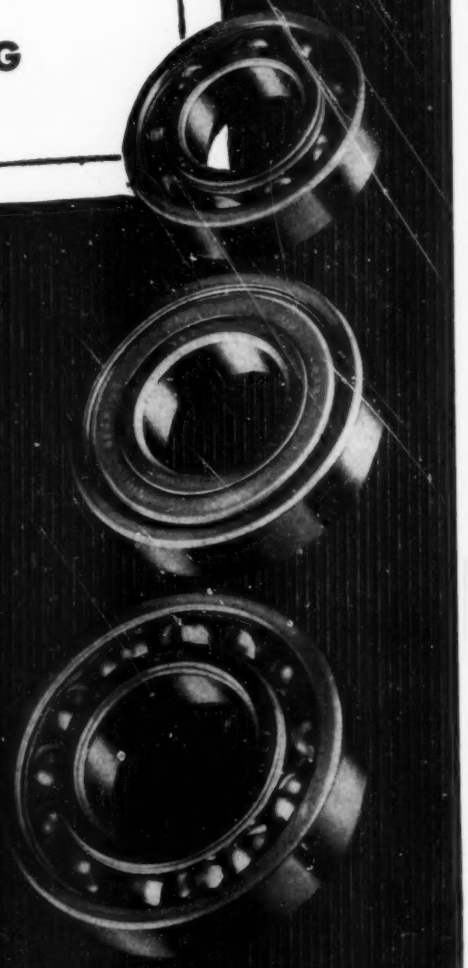
A brilliant mathematician was given an apparently simple but actually extremely difficult problem to solve, a geometric construction. Others had worked at it for days and failed. He solved the problem in a few minutes. When asked how he did it, he smiled and said, "I drew the final configuration and then worked backwards to see how it might be done by geometrical construction". So it goes with many problems.

Individuals are always inclined to ponder a problem without doing anything that might lead to its solution. Perhaps they fail to take action because they consider the first step an insignificantly small fraction of the total solution. But as Confucius pointed out, no matter how long the journey the beginning is always only one little step.

No matter how big and tough the problem may be, get rid of confusion quickly by taking one little step toward its solution. Go ahead and do something even if it turns out to be the wrong thing. Then try again. At the worst, as long as you don't do it the same way twice you will eventually use up all the wrong ways of doing it and thus the next try will be the right one. The truth will eventually emerge out of the errors. Veritas Ex Errore Emergit.

G. F. Rodenhold

Best Things in Life are Free – RUNNING



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TENSION CONTROL for steel strip coiler has torque belt that operates differential controller for measuring power of winder. Controller adjusts variable speed transmission to reset tension.

Mechanical Systems for Controlling Speed and Tension

How to select indicators, controllers and transmissions for regulating the flow of continuously moving metallic and nonmetallic materials.

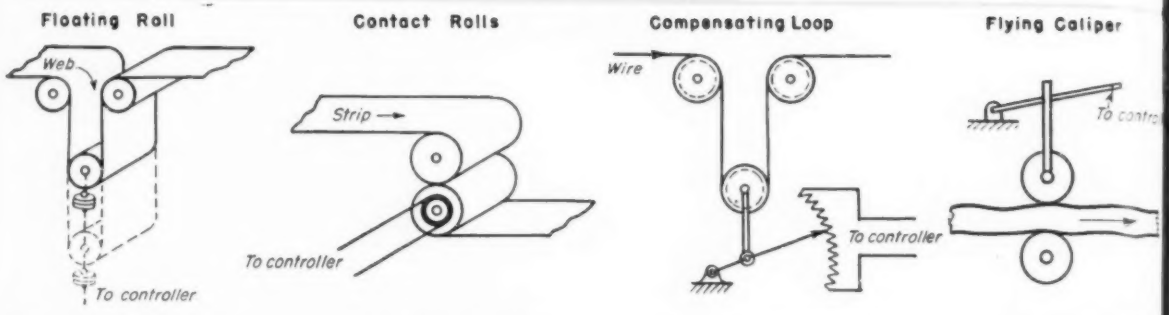
J. H. GEPFERT
Reeves Pulley Company

THE KEY TO THE SUCCESSFUL OPERATION of any continuous processing system that is linked together by the material being processed is positive speed synchronization of the individual driving mechanisms. Typical examples of such a system are steel strip lines, textile equipment, paper machines, rubber and plastic processers and printing presses. In each of these cases, the material will become wrinkled, marred, stretched or otherwise damaged if precise control is not maintained. Each of the driving mechanisms must therefore automatically compensate for variations that tend to change the speed and tension of the material from a desired value.

The automatic control for such a system contains three basic elements: The signal device or indicator, which senses the error to be corrected; the controller, which interprets the indicator signal and amplifies it, if necessary, to initiate control action; and the transmission, which operates from the controller to change the speed of the driving mechanism to correct the error.

Signal indicators for continuous systems fall into two general classifications: Primary indicators that measure the change in speed or tension of the material by direct contact with the material; and secondary indicators, which measure a change in the mate-

TABLE I — PRIMARY INDICATORS



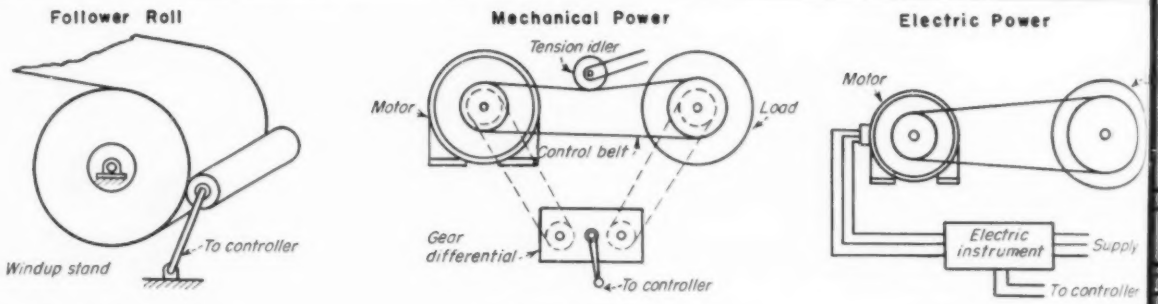
USE: Constant tension winding Registry control; Section synchronizing.

USE: Velocity control; Cutter feed control.

USE: Line tension control; Section synchronizing.

USE: Thickness control; Diameter control.

TABLE II — SECONDARY INDICATORS

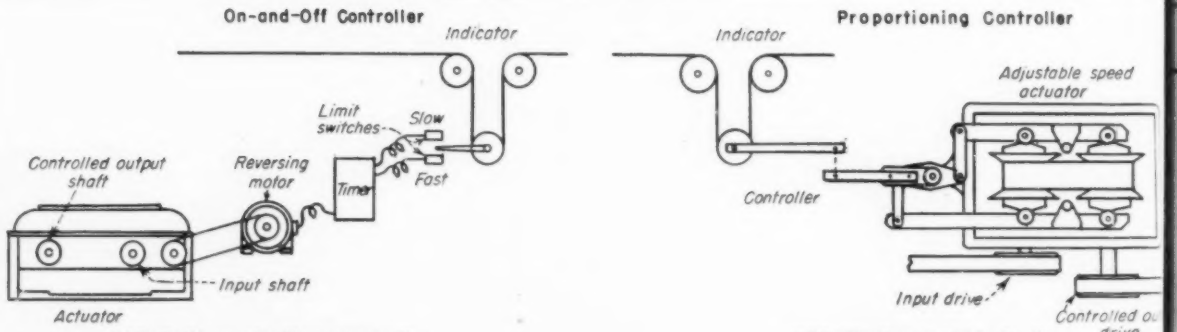


USE: Winder control; Periphery cutting:

USE: Winding tension; Feeder control.

USE: Winding tension; Feeder control.

TABLE III — CONTROLLERS AND ACTUATORS



USE: Delivery rate; Storage capacity; Rough section synchronizing.

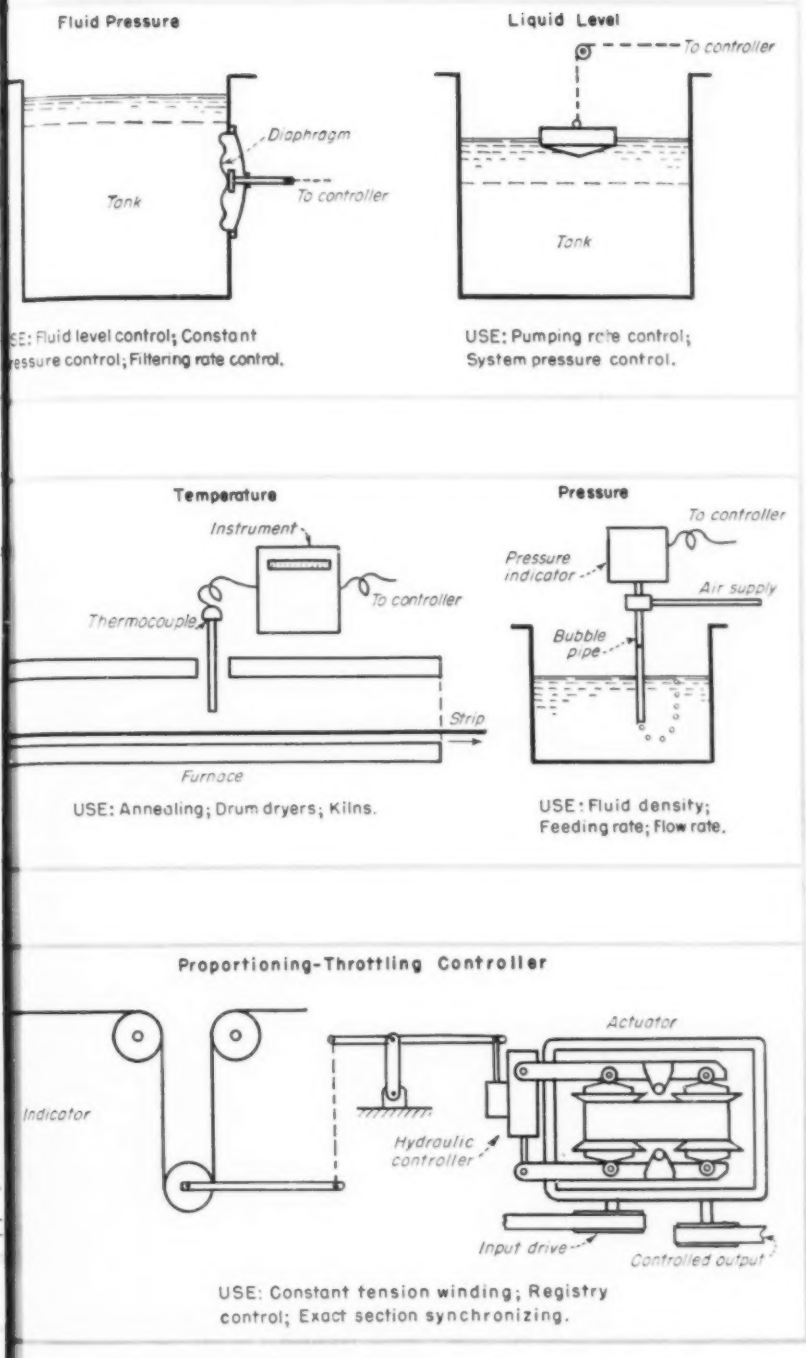
USE: Winding controls; Section synchronizing; Cutter feeds.

rial from some reaction in the system that is proportional to the change.

The primary type is inherently more accurate because of its direct contact with the material. These indicators take the form of contact rolls, floating or compensating rolls, resistance bridges and flying calipers, as illustrated in Table I. In each case, any change in the tension, velocity or pressure of the material is indicated directly and immediately by a displacement or change in position of the indicator element. The primary indicator, therefore, shows deviation from an established norm, regardless of the factors that have caused the change.

Secondary indicators, shown in Table II, are used in systems where the material cannot be in direct contact with the indicator or when the space limitations of a particular application make their use undesirable. This type indicator introduces into the control system a basic inaccuracy which is the result of measuring an error in the material from a reaction that is not exactly proportional to the error. The control follows the summation of the errors in the material and the indicator itself.

The controlling devices, which are operated by the indicators, determine the degree of speed change required to correct the error, the rate at which the correction must be made, and the



stopping point of the control action after the error has been corrected. The manner in which the corrective action of the controller is stopped determines both the accuracy of the control system and the type of control equipment required.

Three general types of control action are illustrated in Table III. Their selection for any individual application is based on the degree of control action required, the amount of power available for initiating the control, that is: the torque amplification required, and the space limitations of the equipment.

The on-and-off control with timing action is the simplest of the three types. It functions on the basis that, when the indicator is displaced, the timer contact energizes the control in the proper direction for correcting the error. The control action continues until the timer stops the action. After a short interval, the timer again energizes the control system and, if the error still exists, control action is continued in the same direction. Thus, the control process is a step-by-step action to make the correction and to stop operation of the controller.

The proportionate type of controller corrects an error in the system, as shown by the indicator, by continuously adjusting the actuator to a speed that is in exact proportion to the displacement of the indicator. The diagram in Table III shows the proportionate controller in its simplest form as a direct link connection between the indicator and the actuating drive. However, the force amplification between the indicator and the drive is relatively low and hence limits this controller to applications where the indicator has sufficient operating force to adjust the speed of the variable speed transmission directly.

The most accurate controller is the proportioning type with throttling action. Here, operation is in response to the rate of error indication. This type of controller, as shown in Table III, is connected to a throttling valve, which operates a hydraulic servomechanism for adjusting the variable speed transmission.

The throttling action of the valve provides a slow control action for small error correction or for continuous correction at a slow rate. For following large errors, as shown by the indicator, the valve opens to the full position and makes the correction as rapidly as the variable speed transmission will allow. This type of control action is free of hunting because it virtually eliminates over-controlling. The control action is stopped by this controller on a self-neutralizing basis, because the control movement caused by the indicator is followed up by the controller until the exact movement has been satisfied. Over-shooting of the control action is prevented by the throttling action of the valve in slowing down the movement of both the rate of control action if the error is small, and the rate at which the point of neutralization is reached when the correction for the error as indicated has been satisfied.

The variable speed transmissions used for correcting the velocity and tension in the system must be infinitely adjustable drives having the same degree of accuracy for adjustment as the indicator and controller. When the transmission is not capable of following the error correction called for by the controller, the system must continuously correct for the error as shown by the indicator and controller.

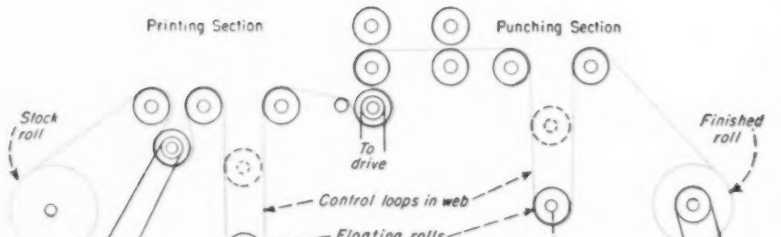


Fig. 1—Floating rolls are direct indicators of speed and tension in the paper web. Controller-actuators adjust feed and windup rolls to maintain registry during printing.

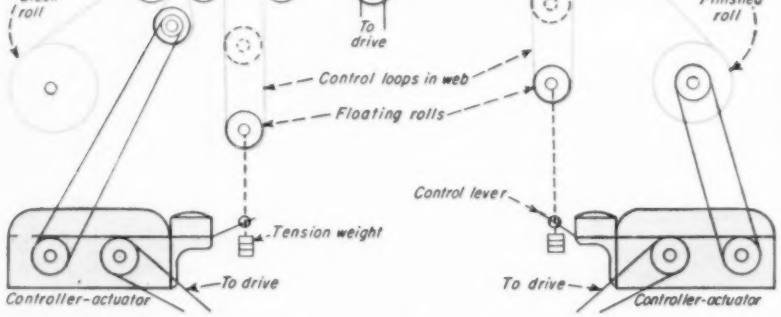


Fig. 2—Dimension control of extruded materials calls for primary indicators like the contact rolls shown. Their movements actuate conveyor control mechanisms.

This condition, in most cases, leads to a hunting or cycling control.

Many continuous processing systems can be automatically controlled by using a package unit consisting of a simple, mechanical, variable speed transmission and an accurate hydraulic controller.

This controller-transmission package can be used to change the speed relationship at the driving points in the continuous system from any indicator that signals for correction by a displacement. It has anti-hunting characteristics because of the throttling action on the control valve, and is self-neutralizing because the control valve is part of the transmission adjustment system.

An example of a continuous processing system that requires automatic control is the rotary type printing press. When making billing forms on such a press, the printing plates are rubber and the forms are printed on a continuous web of paper. The paper varies in texture, moisture content, flatness, elasticity and finish. In addition, the length of the paper changes as the ink is applied.

In a typical application of this type, the accuracy required for proper registry of the printing and hole punching must be held to a differential of 1/32 in. in 15 ft of web. For this degree of accuracy, a floating or compensating roll, as shown in Fig. 1, is used as the indicator, because it is the most accurate means of indicating changes in length of web by displacement. In this case, two floating rolls are used with two separate controllers and actuators, one to control the in-feed speed and tension of the paper stock, and the second to control the wind-up.

The in-feed is controlled by maintaining the turning speed of a set of feeding rolls that pull the paper off the stock roll. The second floating roll controls the speed of the wind-up mandrel. The web of paper is held to an exact value of tension between the feed rolls and the punching cylinder of the press by the in-feed control, and also between the punching cylinder and the wind-up roll. Hence, it is possible to not only control the tension in the web of different grades of paper, but also to adjust the relative length at these two points, thereby maintaining proper registry.

The secondary function of maintaining exact control of the tension in the paper as it is rewound after printing is to condition the paper and to obtain a uniformly wound roll so that the web is ready for subsequent operations.

Control of dimension or weight by tension and velocity regulation can be illustrated by applying the same general type of controller actuator to the take-off conveyors in an extruder line such as those used in rubber and plastics processing. The problem is twofold: First, to set the speed of the take-away conveyor at the extruder to match the variation in extrusion rate; and, second, to set the speeds of the subsequent conveyor sections to match the movement of the stock as it cools and tends to change dimension.

One way to handle this problem is to use as the indicators the pivoted idlers or contact rolls shown in Fig. 2. The rolls contact the extruded material between each of the conveyor sections and control the speed of the driving mechanism of the following section. The material forms a slight catenary between the stations and the change in the catenary length is used for indicating errors in driving speeds.

The plasticity of the material prevents the use of a complete control loop and hence the contact roll must operate with very little resistance or force through a small operating angle. The controller-actuator described in the tension problem above is suitable for providing the high degree of sensitivity required for this operation even though the operating force and the displacement are of very low order. The primary indicator is necessary because of the high degree of accuracy required to hold the extruded product to a uniform cross-section and to prevent distortion that is caused by irregular or improper speed relationships between the take-off conveyor sections. This automatic system not only insures high-quality extrusions, but also increases production rates.

The problem of winding or coiling a strip of thin steel that has been plated or pre-coated for painting on a continuous basis is typical of processing systems in which primary indicators cannot be used. While it is important that no contact be made with the prepared surface of the steel, it is also desirable to rewind the strip after preparation in a coil that is

sound and slip-free. An automatic, constant-tension winding control and a secondary type indicator are therefore used to initiate the control action.

The control system shown in Fig. 3 is used to wind coils from 16 in. core diameter to 48 in. maximum diameter. The power to wind the coil is used as the controlling medium because, by maintaining constant winding power as the coil builds up, a constant value of strip tension can be held within the limits required. Actually, this method is inaccurate to the extent that the losses in the driving equipment, which are a factor in the power being measured, are not constant and hence the strip tension changes slightly. This same factor enters into any control system that uses winding power as an index of control.

A torque measuring belt that operates a differential controller is used to measure the power of the winder. Then, in turn, the controller adjusts the variable speed transmission. The change in speed between the source of power and the transmission is measured by the three-shaft gear differential which is driven in tandem with the control belt. Any change in load across the control belt produces a change in speed between the driving and driven ends of the belt. The differential acts as the controller, since any change in speed between the two outside shafts of the differential results in a rotation or displacement of the center or control shaft. By connecting the control shaft of the differential directly to a screw-controlled variable speed transmission, a means is provided for adjusting the transmission to correct any change in speed and power as delivered by the belt.

This system is made completely automatic by establishing a neutralizing speed between the two input shafts of the differential (within the creep value of the belt). When there is no tension in the strip, for example when it is cut, the input speed to the actuator side of the differential is higher on the driven side than it is on the driving side of the differential. This unbalance reverses the rotation of the control shaft of the differential, which in turn resets the transmission to the high speed required for starting the next coil on the rewinding mandrel.

In operation, any element in the system that tends to change strip tension causes a change in winding power, which, in turn, is immediately compensated for by the rotation or tendency to rotate of the controlling shaft in the differential. Hence, the winding mandrel speed is continuously and automatically corrected to maintain constant tension in the strip.

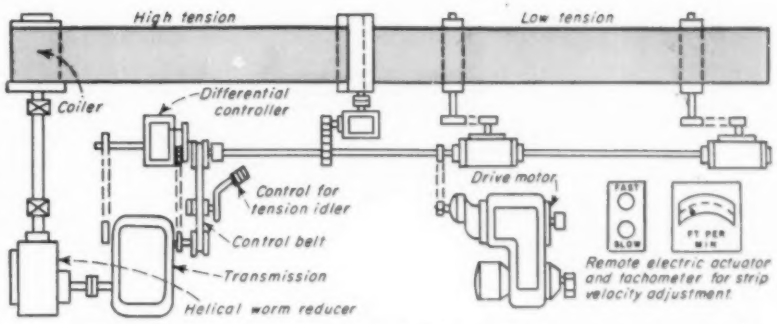


Fig. 3—Differential controller has third shaft that signals remote actuator when tension in sheet material changes. Coiler power is used as secondary control index.

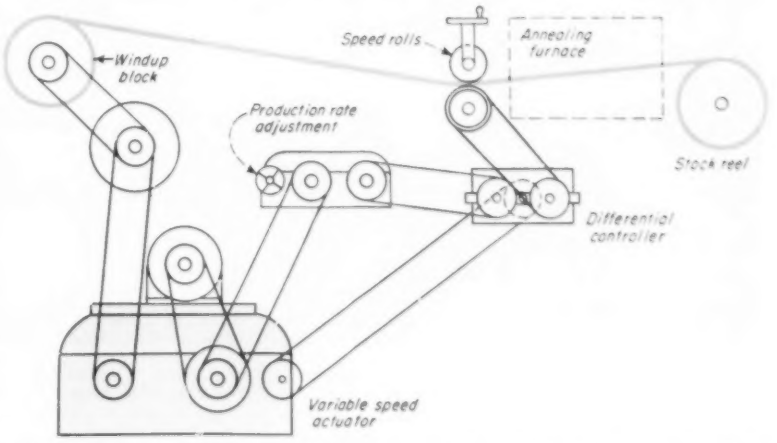


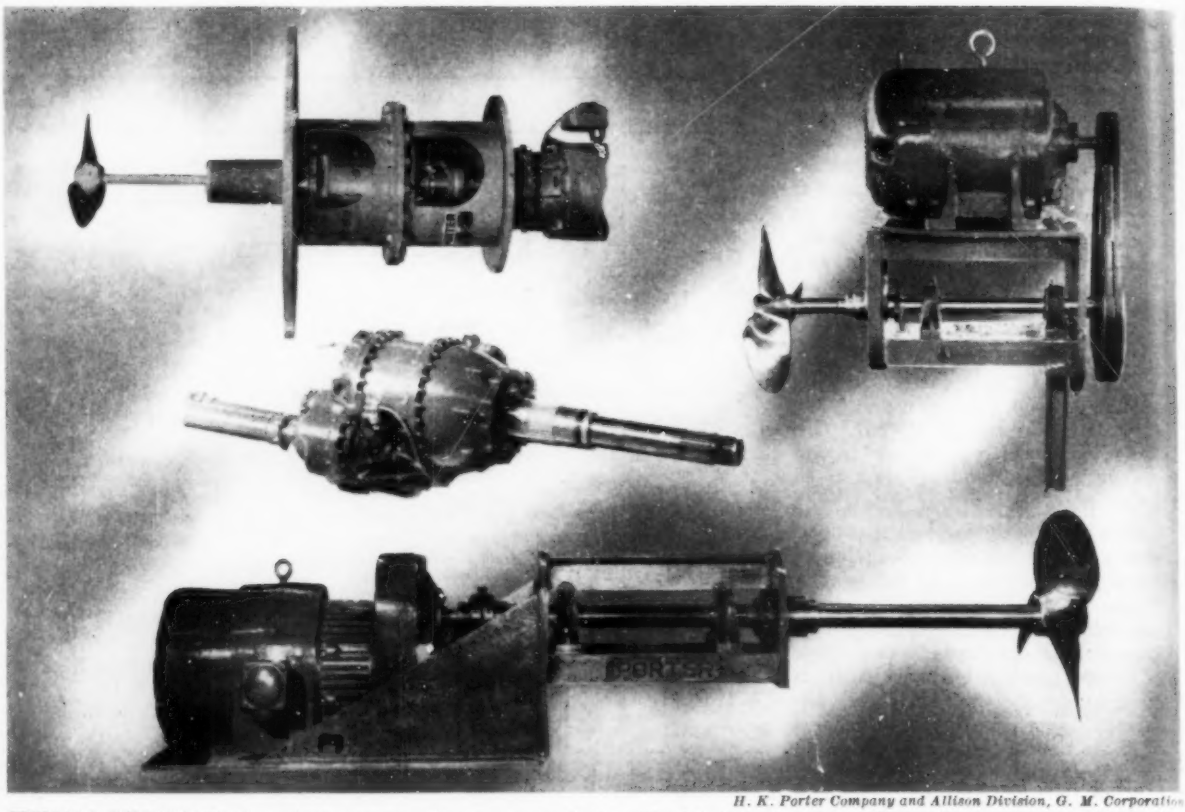
Fig. 4—Movement of wire through annealing furnace is regulated at constant velocity by continuously retarding the speed of the windup reels to allow for wire build-up.

When the correct speed relationships are established in the controller, the system operates automatically for all conditions of operation. In addition, tension in the strip can be adjusted to any value by moving the tension idler on the control belt to increase or decrease the load capacity of the belt to match a desired strip tension.

There are many continuous processing systems that require constant velocity of the material during processing, yet do not require accurate control of the tension in the material. An example of this type is the annealing of wire that is pulled off stock reels through an annealing furnace and then rewound on a wind-up block.

The problem is to pass the wire through the furnace at a constant rate, so that the annealing time is maintained at a fixed value. Since the wire is pulled through the furnace by the wind-up blocks shown in Fig. 4, its rate of movement through the furnace would increase as the wire builds up on the reels unless a control is used to slow down the reels.

A solution to this problem is to use a constant velocity type control with the wire as a direct indication to an indicator that takes the speed of initiate a control action for adjusting the speed of the wind-up reel. In this case, the wire can be contacted directly and a primary type indicator in the form of a contact roll can be used to register any change in speed. The contact roll drives one input shaft of the differential controller. The second input shaft is connected to the driving shaft of the variable speed transmission to provide a reference speed. The third or control shaft will then rotate when any difference in speed exists between the two input shafts. Thus, if the control shaft is connected to a screw-regulated actuator, an adjustment is obtained for slowing down the wind-up blocks as the coils build up and the wire progresses through the furnace at a constant speed.



H. K. Porter Company and Allison Division, G. M. Corporation

TYPICAL EXAMPLES of products incorporating overhung shafts. Coaxial shafts in center illustration support two huge airplane propellers; shafts for the three agitators have different critical frequencies which are determined by length of overhang.

Critical Speeds of Overhung Shafts

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CALCULATIONS IN THE DESIGN of overhung shafts are often complicated by one or more loads concentrated at points remote from the outboard support. For given conditions of loading and support, the critical frequency of a rotating shaft is essentially the same as the natural frequency of a beam undergoing tranverse vibrations. Experiments have shown that a shaft carrying a concentrated load such as an impeller completely immersed in a liquid will not develop undesirable vibrations. But if there is no effective damping medium, as is the case when the shaft and impeller rotate in air, the critical freqency becomes of primary importance and must be carefully evaluated. Assuming the critical frequency is essentially the same whether the shaft is horizontal, vertical or inclined, the following method of calculating critical speeds will be devoted to vertical shafts of the general type shown in Fig. 1.

The relationship between the deflection and spring constant of a shaft makes it possible to determine critical speed from the static deflection for weight loads equal to those of the rotating masses. The general equation for frequency is

$$N = \frac{60}{2\pi}\sqrt{\frac{g}{y}} \qquad (1)$$

where N is the frequency in cycles per minute or rpm, g is the gravitational constant, and y is the static deflection of the shaft in inches. Combining the constants, this equation takes the following form:

$$N = 187.7\sqrt{\frac{1}{y}} \qquad (2)$$

For a weightless cantilever loaded

at its extremity, Eq (2) becomes

$$N = 187.7 \sqrt{\frac{3EI}{WL^3}} \quad (3)$$

in which L equals length of shaft, in.; W equals load, lb; I equals moment of inertia, in.^{4}; and E equals modulus of elasticity, psi. With two or more concentrated loads W_1, W_2. . . . having deflections y_1, y_2. . . . at and under these loads, the frequency equation for the weightless cantilever is

$$N = 187.7 \sqrt{\frac{W_1y_1 + W_2y_2 + \ldots . W_ny_n}{W_1y_1^2 + W_2y_2^2 + \ldots . W_ny_n^2}} \quad (4)$$

For a beam of uniform weight, where the weight is a factor or where a heavy uniformly distributed load is placed along the shaft, a very close approximation to the critical frequency can be established by using a series of terms as in Eq (4). This process is time-consuming, however, and the critical frequency is more easily established by using

$$N = 234 \sqrt{\frac{1}{y}} \quad (5)$$

where y is the deflection brought about by the uniform load alone. For a cantilever of uniform section with a total uniform load w, Eq (5) becomes

$$N = 234 \sqrt{\frac{8EI}{wL^3}} \quad (6)$$

If the critical frequencies of a shaft under two or more systems of loading are known, the frequency of the shaft subjected to combinations of these systems of loads can be obtained from the well-known empirical formula of Dunkerley:

$$N_r = \frac{N_1 N_2}{\sqrt{N_1^2 + N_2^2}} \quad (7)$$

In shaft applications similar to those of Fig. 1, where the overhung length is appreciable, the uniform weight of the shaft is an important factor. The critical frequency of such a shaft with a single load can be found by determining the individual frequencies of the load weight and shaft weight from Eqs (3) and (6), and then combining these in Eq (7). If the shaft carries two or more concentrated loads, the following modification of Eq (7) can be used:

$$N_r = \frac{N_1 N_2 N_3 \ldots N_n}{\sqrt{(N_1 N_2 \ldots N_n)^2 + \ldots (N_1 N_3 \ldots N_n)^2 + (N_2 N_3 \ldots N_n)^2 + \ldots .}} \quad (8)$$

Eqs (3), (6) and (7) can then be combined into the expression

$$N = 187.7 \sqrt{\frac{3EI}{L^3 (W + 0.236w)}} \quad (9)$$

(This equation can also be obtained by making use of the Rayleigh approximation of the energy determination method.) In Eq (9), W is the concentrated load at the end of the shaft, L is the overhang or extension and w is the total weight of this extension. For cold-rolled steel shafts weighing 0.284 lb per cubic inch, and having a modulus of elasticity E of 29,000,000 psi and diameter d, Eq (9) becomes

$$N = \frac{1.681\, d \times 10^6}{L^2 \sqrt{1 + \frac{19W}{Ld^2}}} \quad (10)$$

The foregoing expressions treat the shaft as though it were a rigidly supported or built-in cantilever. If the shaft is supported in three bearings, or by two bearings and a stuffing box with a suitable lantern ring (essentially a sleeve bearing), these equations can be used because the bearings and the supporting structure usually introduce sufficient damping to obviate the long and complex calculations required for three-bearing deflection data. For shafting similar to that shown in Fig. 1 and particularly when the bearing span is of some magnitude in comparison to the shaft extension, as in Fig. 2, a bearing span factor S should be introduced to take into account the additional deflection and consequent decrease in the critical frequency.

The deflection of a built-in cantilever with a single load is

$$y_1 = \frac{WL^3}{3EI} \quad (11)$$

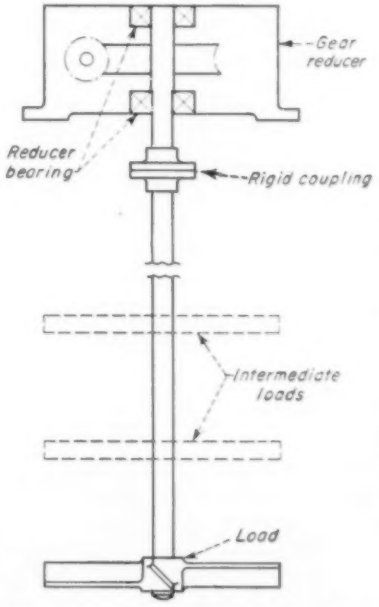


Fig. 1—Typical overhung shaft with single load at end. Calculation of critical frequency becomes complicated if one or more additional loads are concentrated at intermediate points along the shaft.

and the deflection at the overhung end of a simply-supported overhanging beam is

$$y_0 = \frac{WL^2 (L + B)}{3EI} \quad (12)$$

where B is the distance in inches between the supports or the span, L is the overhanging length and $(L+B)$ is the total length of the beam. The ratio between these deflections is therefore

$$\frac{y_1}{y_0} = \frac{L}{L + B} \quad (13)$$

Since the critical frequency of a cantilever shaft, as indicated by Eqs (2), (3) and (5), is proportional to the square root of the reciprocal of the deflection, the frequency of a shaft supported by two bearings is

$$N = 187.7 \sqrt{\frac{1}{y}} \sqrt{\frac{L}{L + B}} \quad (14)$$

from which the bearing span factor S becomes

$$S = \sqrt{\frac{L}{L + B}} \quad (15)$$

The deflection of a uniformly-loaded beam of span B and overhung length L under a total uniform load w is

$$y = \frac{wL^3}{8EI} \left[\frac{4BL^2 + 3L^3 - B^3}{3L^2 (L + B)} \right] \quad (16)$$

Since the deflection of a uniformly loaded cantilever is $wL^3/8EI$, the expression

$$S = \sqrt{\frac{3L^2 (L + B)}{4BL^2 + 3L^3 - B^3}} \quad (17)$$

can be applied as the bearing span factor in conjunction with Eq (5), if the bearing arrangement is such that the added deflection is of importance.

In the application of the bearing span factor S to Eqs (9) and (10), this factor should be a modification of the values obtained from Eqs (15) and (17). For any ratio of L/B, however, the values from Eq (15) are always smaller than those from Eq (17). In vertical shafts, the ratio L/B is rarely less than four and the difference between the two values of S does not exceed six percent. Since the computation and formulation of a modified factor embodying both values of S is extremely involved, it is customary to use the bearing span factor from Eq (15) for the conversion of Eqs (9) and (10).

If the shaft carries more than one concentrated load, it is necessary to determine the frequency from Eqs (3), (4) and (6). A simple method is to convert the weights of any loads not at the extremity of the shaft to

an equivalent weight W_e at the end using the expression

$$W_e = \frac{W_1L_1^3 + W_2L_2^3 + \ldots . W_nL_n^3}{L^3} \quad (18)$$

where W_1, W_2, . . . W_n are separate loads at distances L_1, L_2, . . . L_n from the first point of support or lower bearing, and L is the distance from the point of support to the end of the shaft. The quantity W_e is then added to the load W in Eqs (9) and (10).

When the critical frequency of a shaft of a given diameter is desired, the critical speed can be obtained from Eq (10) for cold-rolled steel. For shafts of other materials, the critical speed can be obtained by multiplying the value from Eq (10) by a modulus factor M. This value is based on the square root of the ratio between the product of the specific gravity and modulus of elasticity of the material considered, and the product of the specific gravity and modulus of cold-rolled steel. Values of M for some of the more common shaft materials are given in Table I. When the shaft and concentrated load are covered or coated with lead or hard rubber, it is necessary to compute the weight of the shaft covering and treat it as part of the uniform load w in Eq (9).

Table I—Constants for Shaft Materials

Material	$E / 10^6$	Wt per cu in.	Modulus Factor, M
Cold-rolled Steel	29.0	0.284	1.000
Stainless Steel...	28.6	0.286	0.990
Nickel.....	30.0	0.320	0.940
Monel.....	26.0	0.318	0.895
Phos. Bronze...	16.0	0.314	0.707
Aluminum.....	10.0	0.098	1.002

In many instances, the load weight, the overhung length and the speed are known and the minimum shaft diameter for safe operating characteristics must be determined. Eq (9) or (10) may require several successive trial substitutions. Fig. 3 shows a series of curves for standard steel shaft diameters from which a diameter can be selected relatively quickly. The horizontal scale gives values for the product of the overhung weight and the cube of the overhung length, while the vertical scale gives the critical frequency (speed) in rpm. In applying the chart, it is advisable to use only the overhung weight of the load, and then go to the next larger size shaft and recompute, including the proper proportion of shaft weight in the L^3W factor. It is recommended that actual calculations from Eq (9) or (10) be made as a final check in important designs, because the scale of the chart is small.

Sample Calculations

The following examples illustrate the application of these data:

EXAMPLE 1. A 2-in. diameter cold-rolled steel shaft, similar to that in Fig. 1, carries an impeller weighing 50 lb at its lower end. The overhung length of the shaft is 100 in. taken from the midpoint of the reducer bearing to the midplane of the impeller. If the bearing span is 20 in., what is the critical speed of the shaft?

SOLUTION: The bearing span factor S, from Eq (15), is

$$S = \sqrt{\frac{100}{100 + 20}} = 0.913$$

The critical frequency from Eq (10) and the above is

$$N = \frac{1.681\,(2)\,10^6 \times 0.913}{100^3\sqrt{1 + \frac{19\,(50)}{100\,(2^2)}}} = 167 \text{ rpm}$$

As a check on this result, the combined critical frequency is found by determining the frequencies peculiar to the impeller and shaft weights alone, and then summing these by using Dunkerley's formula. From Eq (17)

$$S = \sqrt{\frac{3\,(100^3)\,(100 + 20)}{4\,(20)\,(100^3) + 3\,(100^3) - (20^3)}} = 0.95$$

From Table II, the weight of a 2-in. diameter shaft is 0.89 lb per inch of length; the total weight w of the shaft is therefore 89 lb. The moment of inertia I of a circular section is $0.49d^4$ or 0.785. From Eq (6),

$$N = 234\,(0.95)\sqrt{\frac{8\,(29)\,(10^6)\,(0.785)}{89\,(100^3)}} = 317 \text{ rpm}$$

and from Eq (3)

$$N = 187.7\,(0.913)\sqrt{\frac{3\,(29)\,(10^6)\,(0.785)}{50\,(100^3)}} = 200 \text{ rpm}$$

Using these two values of N in Eq (7)

$$N_r = \frac{200\,(317)}{\sqrt{200^2 + 317^2}} = 169 \text{ rpm}$$

The difference of 2 rpm in these results, as compared to those of the preceding solution, is traceable to the use of the simplified bearing span factor in the first solution.

Table II—Shaft Data

Diameter in.	Wt per in. of length lb	Moment of inertia, I
¾	0.125	0.016
1	0.220	0.049
1¼	0.350	0.120
1½	0.50	0.249
1¾	0.680	0.460
2	0.890	0.785
2¼	1.130	1.258
2½	1.390	1.918
2¾	1.680	2.807
3	2.000	3.976
3½	2.720	7.366
4	3.560	12.566

EXAMPLE 2. It is desired to find the critical frequency of the shaft in the preceding example, if the shaft and impeller are covered with lead. The additional weight of the impeller is 30 lb and the lead coating on the shaft is ¼ in. thick.

SOLUTION: Lead weighs 0.41 lb per cu in. so that the weight of the lead covering on the shaft is $0.7854(2.5^2 - 2^2)\,(0.41)$ or 0.73 lb per inch of length. The total weight of the shaft is therefore $(0.89 + 0.73)\,100$ or 162 lb. Similarly, the total weight of the

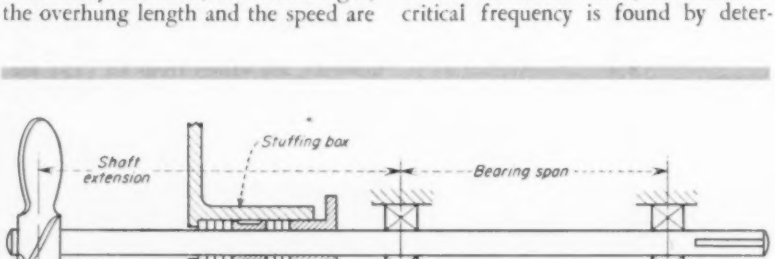
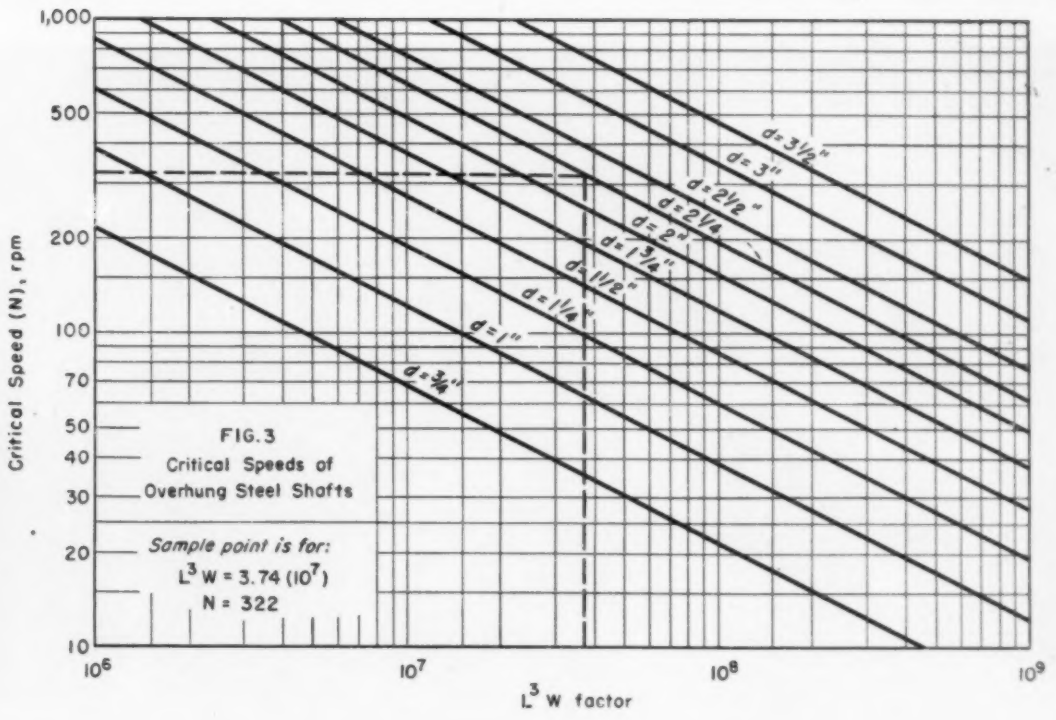


Fig. 2—A bearing span factor should be used in calculating the critical frequency of a shaft when the distance between bearings is relatively long in comparison to the shaft extension. This condition reduces the critical frequency.



lead-covered impeller is (50 + 30) or 80 lb. The critical speed, from Eq (9) is

$$N = 187.7 \sqrt{\frac{3\,(29)\,(10^6)\,(0.785)}{100^3\,[80 + 0.236\,(162)]}} \times (0.913) = 129 \text{ rpm}$$

A comparison of this figure with the solution to Example 1, in which the same shaft size and overhang were used, is indicative of the pronounced effect of additional weight without compensating stiffness.

EXAMPLE 3: An agitator design, similar to that of Fig. 1, has two impellers. One weighing 60 lb is located at the end of the shaft 80 in. below the lower bearing, the other weighing 40 lb is 55 in. below the same bearing. The distance between bearings is 18 in. The speed of the impellers is to be approximately 200 rpm, the critical frequency of the shaft to be at least 30 percent greater than the operating speed and the shaft and impellers to be made of Monel. The problem is to determine the diameter of the shaft.

SOLUTION: In selecting the size of a steel shaft from Fig. 3, it should be remembered that the diameter choice must be based upon a critical frequency 30 percent higher than the operating frequency and that the effect of the bearing span deflection is not included. The critical frequency required for a steel shaft is therefore 200 (1.30) or 260 rpm. The frequency for a comparable Monel shaft is equal to the quotient of the steel shaft frequency and the modulus factor, from Table 1, or 260/0.895 or 291. Allowing for the bearing span factor S, which is equal to the square root of the expression 80/(80 + 18) or 0.904, the frequency becomes 291/0.904 or 322 rpm. The equivalent weight of the upper impeller, from Eq (18), is therefore

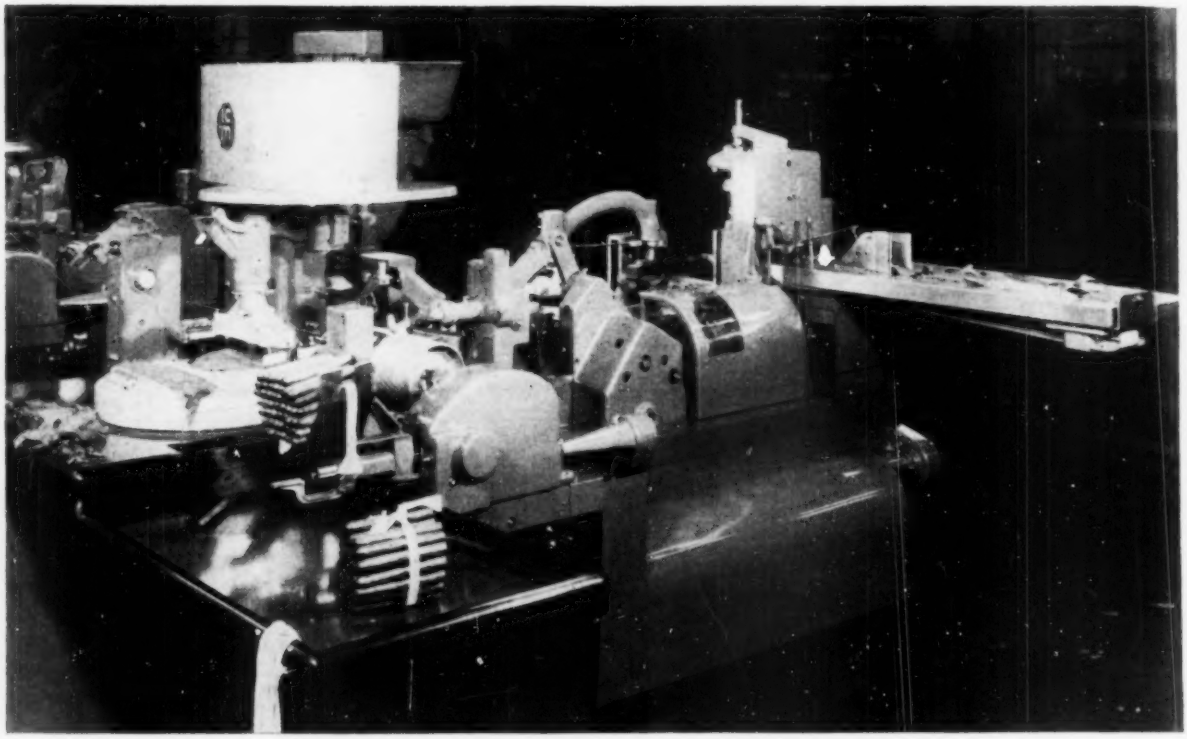
$$W_e = \frac{40\,(55^3)}{80^3} = 13 \text{ lb}$$

The total weight to be considered at the extremity of the shaft is thus (60 + 13) or 73 lb. The value of the L^3W' factor, considering only the impeller weights as a preliminary trial, is $80^3(73)$ or $3.74(10^7)$. From Fig. 3, as illustrated by the broken lines, the shaft diameter for this value of L^3W' and for a rated frequency of 322 rpm is slightly greater than 2¼ in. Since the L^3W' value on which this diameter is based does not include the weight of the shaft, the next larger standard size should be selected and checked. The unit weight of a 2½ in. diameter shaft is 1.39 lb. per cubic inch. The total weight increment to be considered is therefore 1.39 (80) (0.236) or 26.2 lb. The L^3W' value thus becomes 80^3 (73 + 26.2) or $5.08(10^7)$. (It should be noted that the weight of a steel shaft is being considered, not that of a Monel shaft; the effect of the added weight of the latter material is accounted for by the use of the modulus factor in the re-evaluation of the required critical frequency). Reference to Fig. 3 for a rated frequency of 322 rpm shows that a 2½ in. diameter shaft has excess capacity as far as critical speed is concerned.

The actual critical frequency of a 2½ in. diameter shaft from Eq (9) is

$$N = 187.7 \sqrt{\frac{3\,(26)\,(10^6)\,(1.918)}{80^3\,[73 + 0.236\,(125)]}} \times (0.904) = 286 \text{ rpm}$$

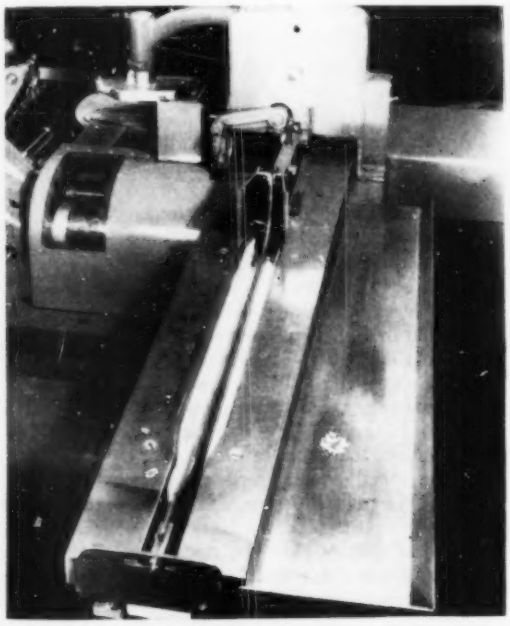
This figure of 286 rpm is more than 40 percent greater than the approximate operating speed of 200 rpm, so that the original 30 percent factor of safety is more than satisfied.



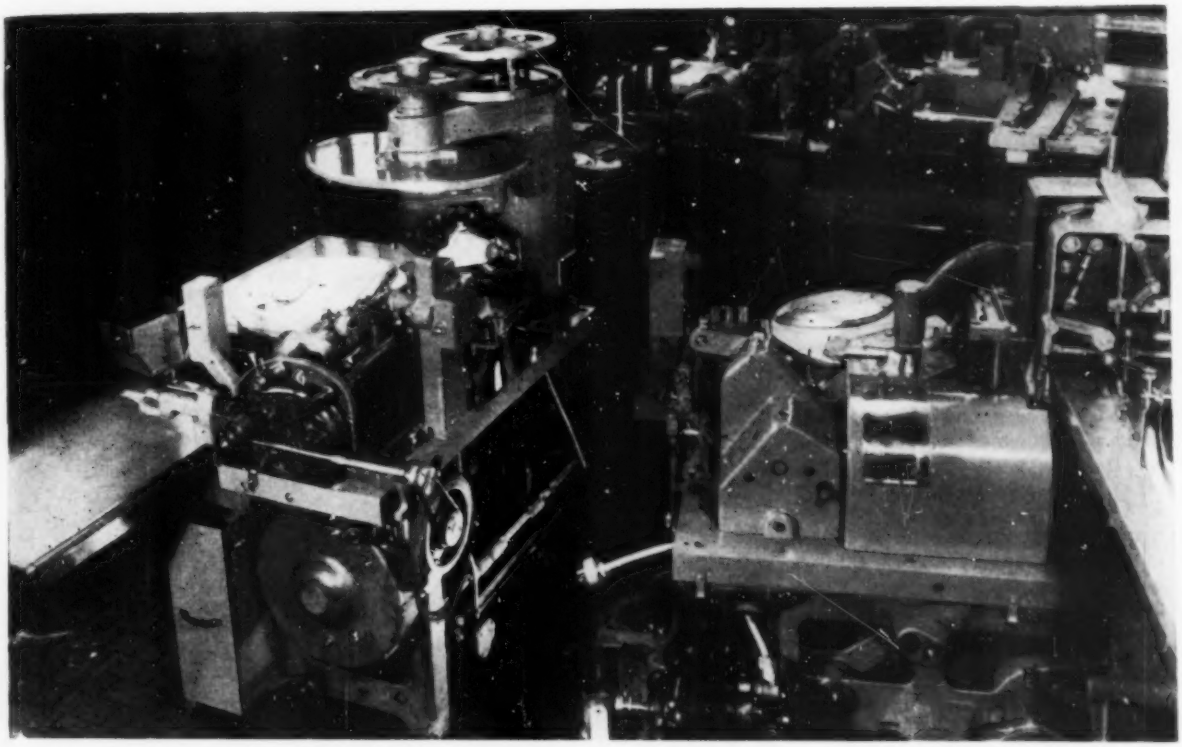
STREAMLINED DESIGN gives eye appeal. Protective casings conceal ½ hp motor which drives rollers and manipulates mechanical carrying hands through gear trains and plate cams. Vacuum arms to transfer thin wrapper leaves are also driven by the motor. Filler tobacco is fed in at the right; finished cigars are inspected in foreground.

Interchangeable Parts Key to Cigar Maker

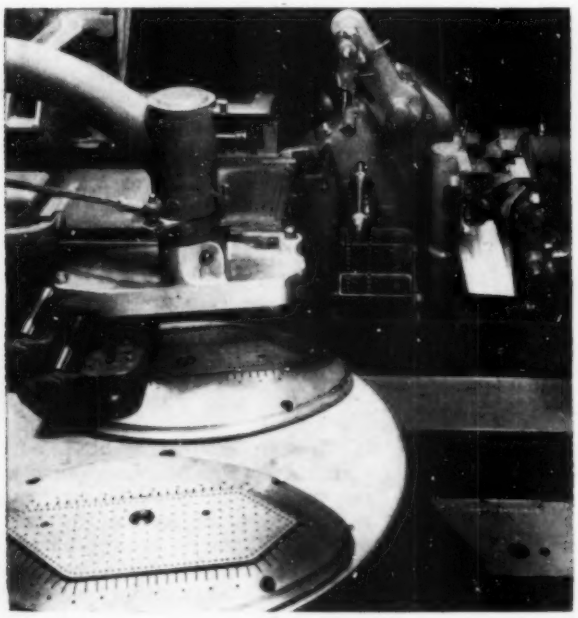
Over 700 cigar shapes are made to suit every whim of the smoking public. This wide range of production is a tall order for one automatic machine. Interchangeable parts was American Machine and Foundry's answer in their new cigar maker with maximum production of 13 cigars per minute for any size or shape. Rollers, cams, levers and cutters are changed to suit production. The Bunch End, where filler tobacco is mixed and gets its inside wrapper, can be unbolted and replaced when production converts from long to short fillers. V-belts transmit power between sections to operate main drive shafts. Three operators feed in filler and wrapper leaves. A fourth girl inspects finished cigars and corrects small defects in end shape. Photo-electric beams cut power when operators' hands come too close to moving parts. After feeding, the entire operation is automatic until cigars roll out on the inspection table.



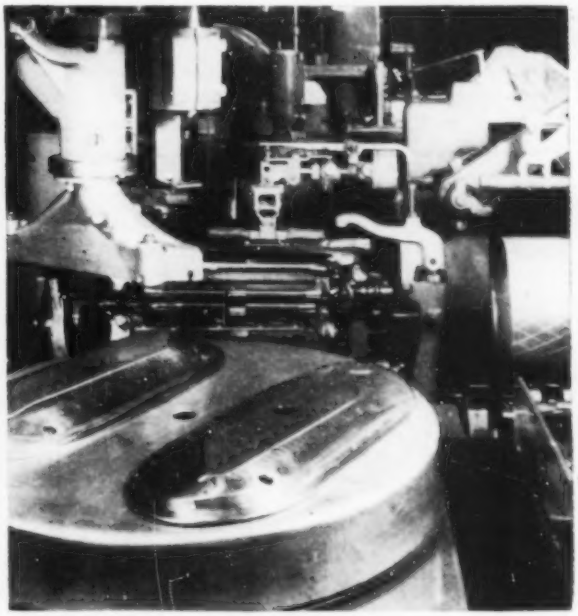
LONG FILLER is laid in slots and carried into the bunching head by belt underneath. Adjustable dividing arm varies ble id. Regulating device automatically refuses oversupply.



BUNCH END at right handles long fillers. A similar component, with a feeder hopper instead of slots, is bolted to the Rolling End to handle short fillers. The filler is rolled up in inner wrapper and transferred to Rolling End at left to receive outer wrapper and have ends finished. Drive shaft underneath the Rolling End is V-belt driven.

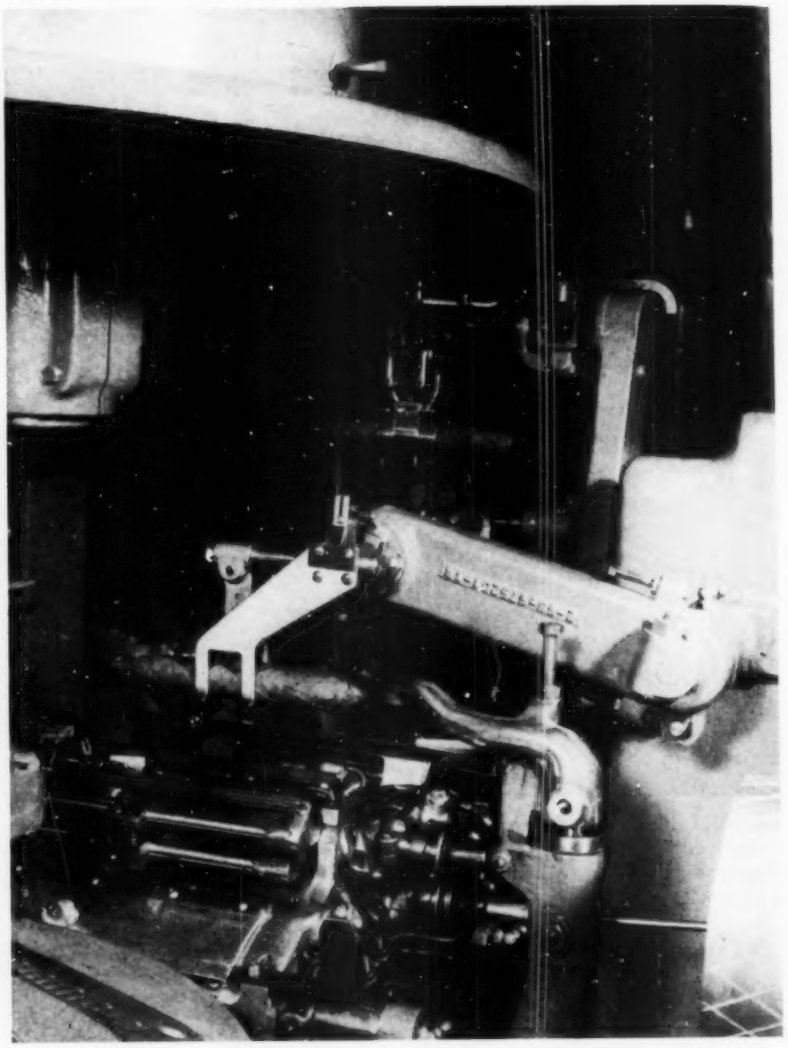


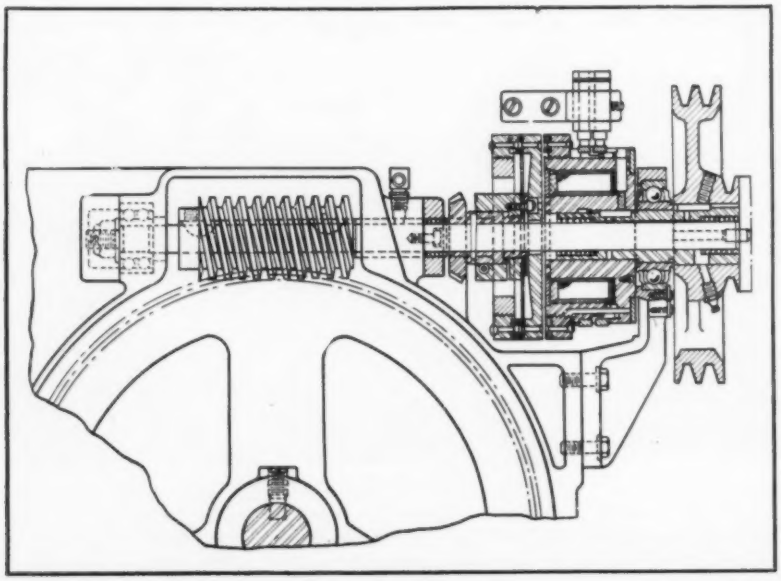
SUCTION ARM transfers wrapper from cutting patterns to belt. Filler is rolled in wrapper as in a home cigarette roller. Claw brushes cigar against glue-carrying chains and drops it in square trough where knife arms trim the end.



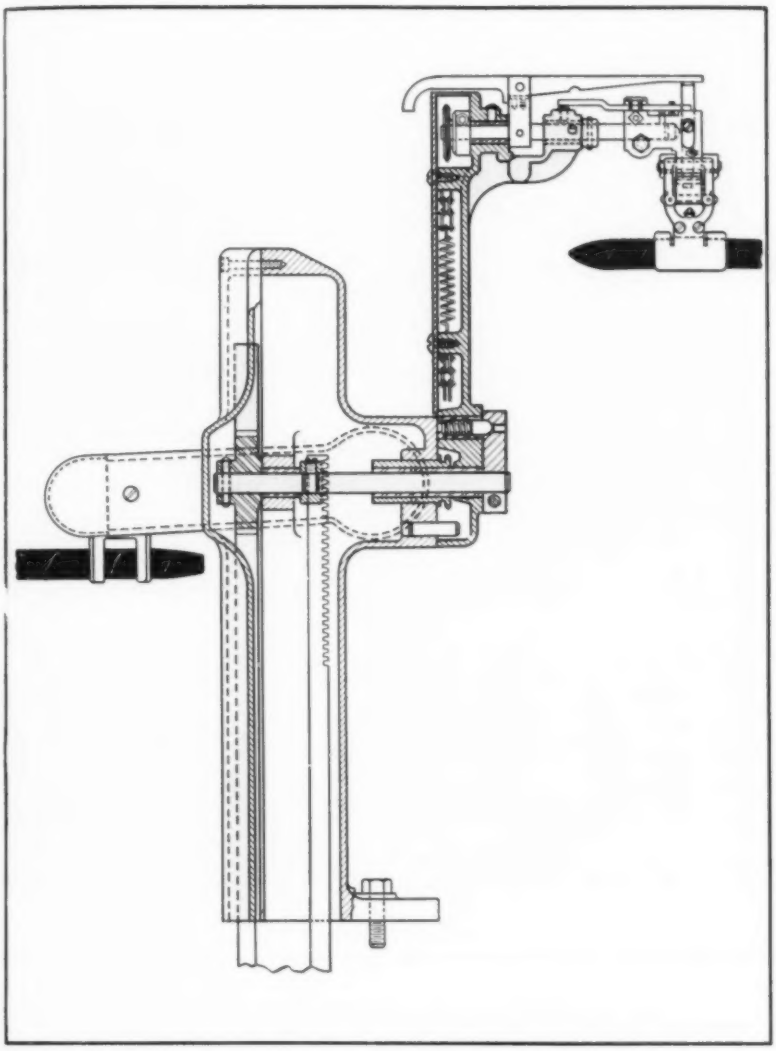
SPRING LOADED ROLLER CRADLE receives cigar and the outer wrapper is pealed off suction arm face as cigar rotates. Ends are knurled here. Claw then drops cigar on curved slide for final rounding roll before inspection.

AFTER CLIPPING, cigar is lifted into spring loaded roller cradle which opens to receive it. Transfer claw opens and pulls clear, leaving cradle free to close. Rollers rotate cigar, pealing outside wrapper leaf off the bottom of suction transfer arm and smoothing it on cigar where it is held by glue. Rollers and knurler operate off Roll End drive shaft underneath. The suction arm is positioned by a large cam on the same shaft which synchronizes its motion with cradle roller rotation. Rapper leaves are cut to shape to fit each cigar model by patterns on a turntable. Operator spreads leaf over knife-edge outlined pattern; the turn table then rotates the pattern 180 deg toward the machine. Slightly tilted rollers run over the leaf, cutting the edges. As the rollers swing clear, the center of the pattern is cammed out to protrude above the turntable and carry the shaped wrapper leaf up to the under face of the suction arm where it is picked up by air pressure and swung over to the cigar rotating in the roller cradle. A photoelectric beam stands guard across the turntable; if any part of the operator's body approaches the moving machinery, power is automatically shut off. Barrel and plate cams are used extensively throughout the mechanism to transmit eccentric motions and ensure sychronization of movements. In changing cigar models, the internal mechanisms are not touched; new cutting patterns, knurlers and filler feeders are substituted. Bottom of preceding page shows the two wrapper turntables in action at both the roll and bunch ends of the machine.

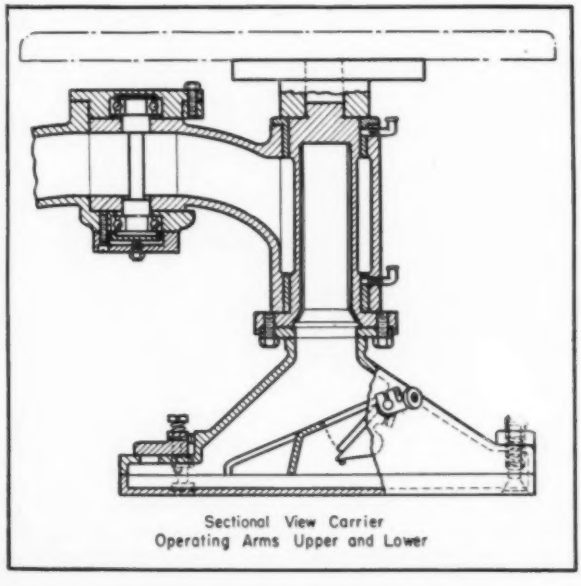




V-BELT SHEAVE on Roll End is driven from motor attached to Bunch End. Power is transmitted through a magnetic clutch to a worm gear which drives the Roll End main power shaft. Eddy clutch was designed by American Machine and Foundry engineers and is built in the company's shops. Between the clutch and the worm gear a bevel gear is keyed to the shaft in position to mesh with another bevel gear on a hand crank shaft at 45 deg to the drive shaft. The hand crank shaft is spring loaded out of mesh so that an inward pressure on the crank is necessary to engage the gears and permit small movements of the mechanisms to be made for adjustments and repairs. Single row ball bearing takes radial loads while double row bearing takes combination radial and thrust loads. The entire machine weighs 3,615 lbs., set up for production on floor of cigar factory.

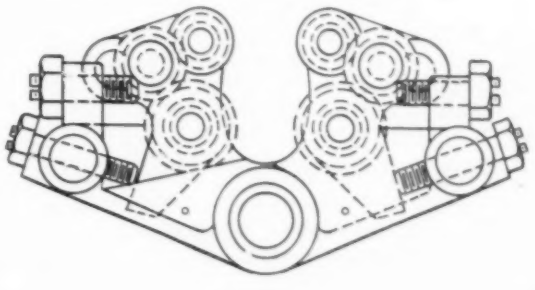


TRANSFER CLAWS are operated from drive shaft below by a rack and pinion mechanism. The rack is actuated by the shaft at the bottom of the machine and transmits straight line motion to the transfer arm head, engaging the pinion which turns a shaft in the head. Attached to this shaft is the transfer arm. At the end of the arm, the claw is fixed on another shaft which is free to rotate in bushings in the arm casting. This shaft is connected by roller chain to a stationary sprocket at the pivot of the arm, and as the arm turns, the claw is rotated by the relative motion of the moving sprocket around the stationary sprocket. This holds the claw in a vertical position throughout the arm movement and the cigar remains below the claw shaft. A spring in the roller chain takes up for wear and maintains constant tension. The transfer arm, its shaft and the motivating rack are shown in color; the stationary head, the claw, its shaft and the roller chain sprockets are drawn in black. The claw jaws are opened and closed by the two levers shown. One is cammed up by a button on the transfer arm casing and operates from the relative motion of the claw shaft and the arm, with no outside stops. The upper lever is tripped by an adjustable stop on the machine casing and opens the jaws when the arm has swung down to a position to deposit the cigar in the roller cradle. Opening and closing of the jaws can be adjusted to close limits and the position of the transfer arm on its pivot shaft can also be varied to correct slight misalignments.



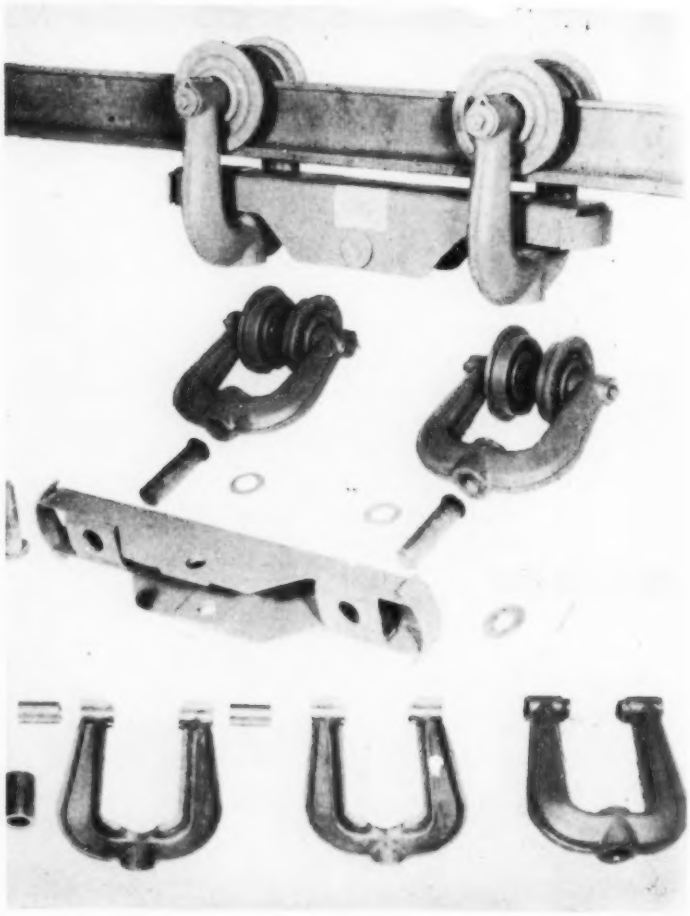
Sectional View Carrier
Operating Arms Upper and Lower

VACUUM TRANSFER ARM for outside wrapper holds leaf as it rolls on to cigar. When half of leaf has been pealed off, the inrush of air closes swing valve, restoring full suction on the remaining part of the leaf. This prevents the wrapper leaf from falling off prematurely and maintains tension in winding. The cradle rollers (below) are spring loaded inward as well as with respect to each other. This gives a firm grip on cigar and helps round out irregularities. All spring tensions can be adjusted to suit conditions.



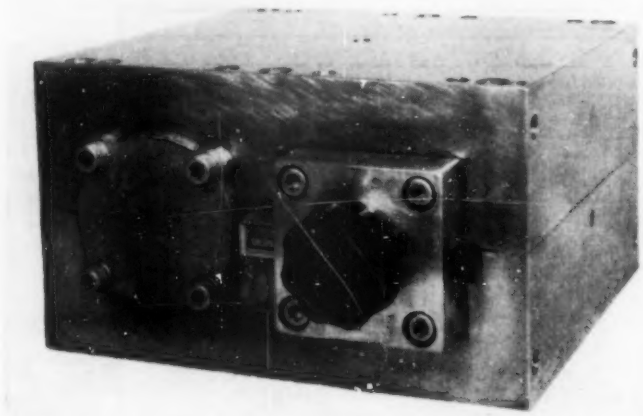
Lightweight Yoke Results From Redesign

The load elements in a tramrail installation consist of the user's maximum load, the grab weight, hoist weight, and the trolley weight. Any reduction in the weight of the trolley means that a larger payload can be handled. The Ohio Tramrail, made by the Forker Corp. of Cleveland, Ohio, was designed to cut this excess weight without resultant losses in strength. The company reports that the weight saving, plus a lower draw bar pull through reduction of friction, has resulted in a 5 to 15 percent increase in payload. The trolley yoke is a typical part of the newly designed trolley. An analysis of live load conditions showed five common stresses which are normally encountered. A modified tube yoke has strength in strategic locations and weighs 50 percent less than previous yokes.

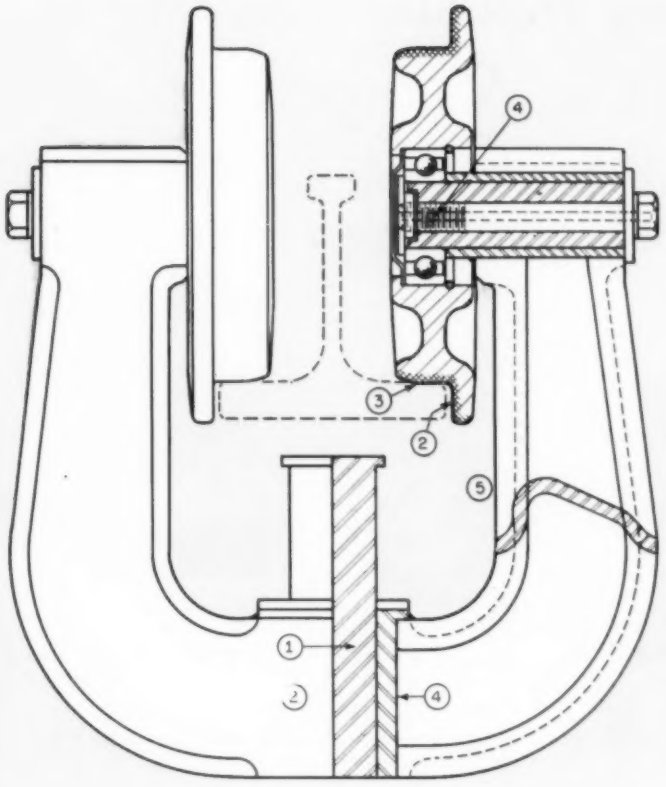


Adjustable Oscillator

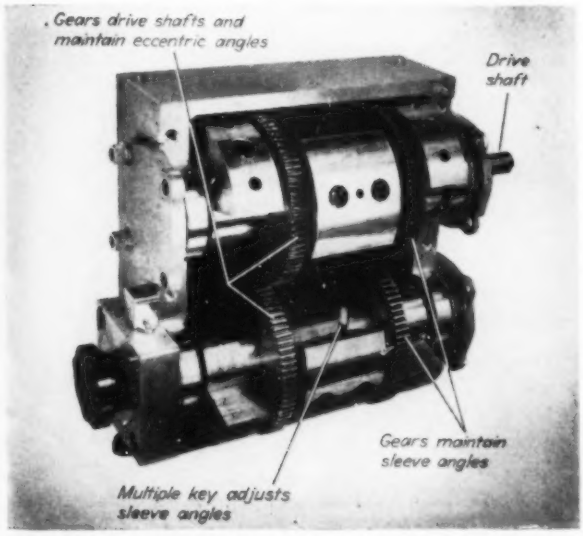
Used to induce controlled vibrations in structures and assemblies, the Lazan oscillator employs a unique system of eccentrically supported weights to allow the machine to be controlled either while stationary or while running. The eccentrics are so located and so rotated that all forces add in one direction, and mutually cancel each other in all other directions. The device is powered by a constant speed ½ hp motor or a 1 hp variable speed motor drive of the Thyratron type. The oscillator is made by the Baldwin Locomotive Works.



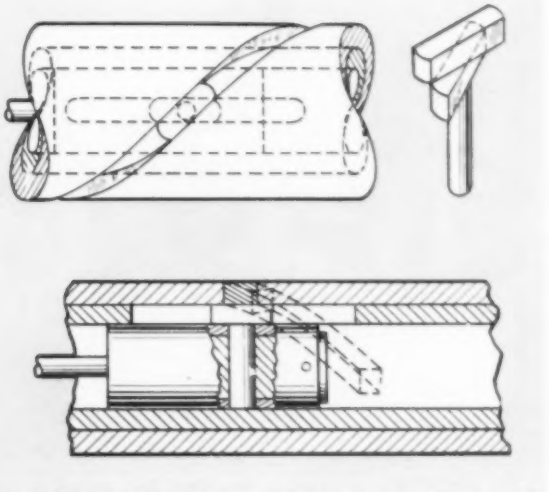
HOUSING is a split magnesium ca·ing. The control knob regulates the relative position of eccentric weights, to control vibrating force. Force output is also a function of the rotating speed, which can be read directly from counter on the front next to the control knob.



UNDER LIVE LOAD CONDITIONS there are five common points of stress concentration in this trolley yoke. They are: (1) simple beam stresses concentrated at the kingpin bushing and caused by one-half the weight of the trolley load bar; (2) cantilever load stresses caused by the wheel flange resisting the side thrust of centrifugal forces as the trolley travels around a curve; (3) load support stresses transmitted down the yoke arms, but concentrated on the inside of the yoke due to the hook design influence; (4) torsional stresses developed at the bottom of the yoke and caused by the impact of a single wheel striking the safety guard; and (5) occasional cantilever stresses caused by side pulling with the hoist when the load is not under the truck. The problem is complicated by the fact that these stress conditions can develop singly or in any combination repeatedly in the course of normal operation. Maximum stresses occur on the tension side of yoke. This was overcome by use of a modified tube cross-section similar to a hook design. The bulk of the metal was concentrated on the tension side. Weight reduction was achieved by the use of two steel stampings welded back-to-back. The king pin bushing on which the loadbar rides was also welded. Continuous welds extend two inches up from the base on the tension side.

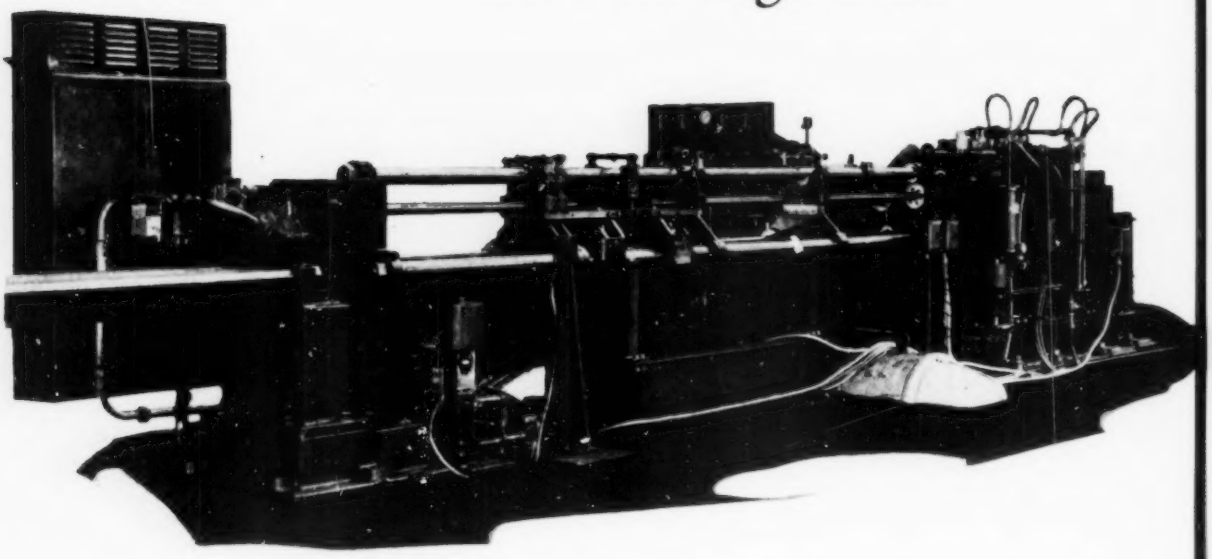

Gears drive shafts and maintain eccentric angles
Drive shaft
Gears maintain sleeve angles
Multiple key adjusts sleeve angles

SPUR GEARS on the left drive the two shafts in opposite directions. Gear set on the right maintains relative angular position location of sleeves, which control center eccentric weights. One side of casing is removed to give inside view.

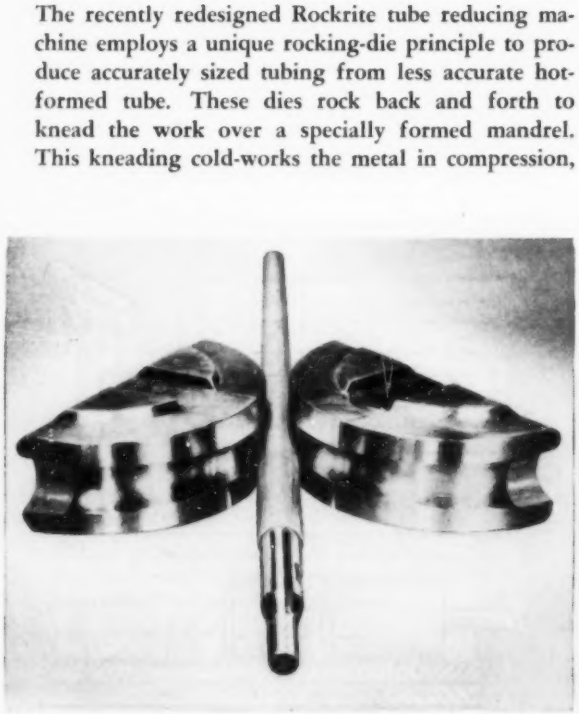


MIDDLE ECCENTRICS are adjusted by this patented multiple key, which rotates the sleeves and shafts relative to each other, thus varying the angle between middle and end eccentrics to control the force even while running.

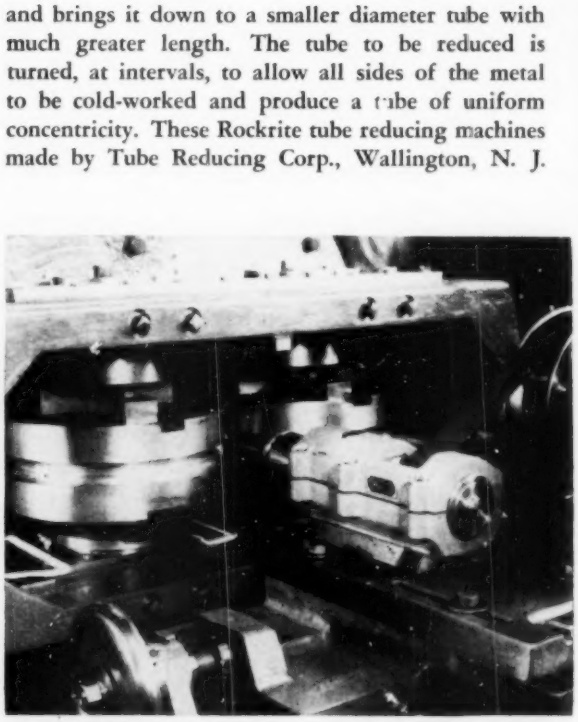
Tube Reducing Machine Has Novel Die Arrangement



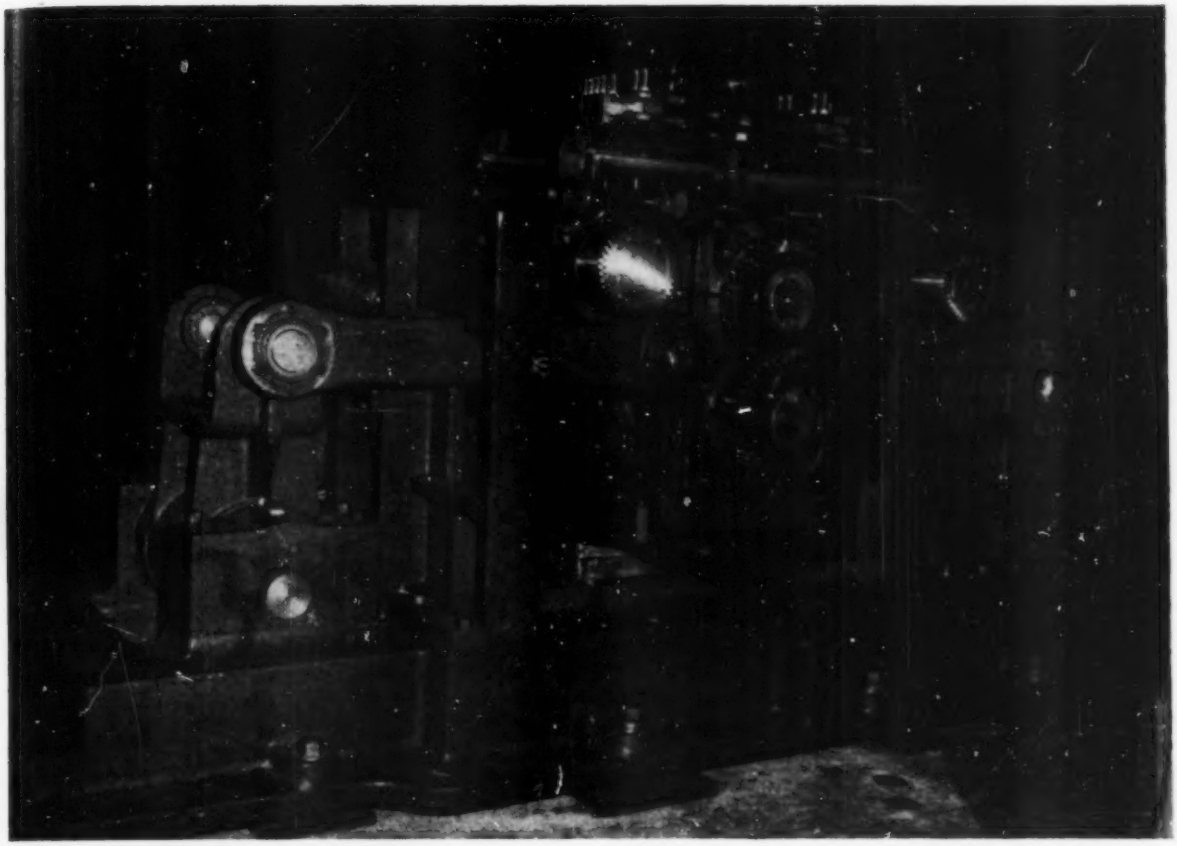
The recently redesigned Rockrite tube reducing machine employs a unique rocking-die principle to produce accurately sized tubing from less accurate hot-formed tube. These dies rock back and forth to knead the work over a specially formed mandrel. This kneading cold-works the metal in compression, and brings it down to a smaller diameter tube with much greater length. The tube to be reduced is turned, at intervals, to allow all sides of the metal to be cold-worked and produce a tube of uniform concentricity. These Rockrite tube reducing machines made by Tube Reducing Corp., Wallington, N. J.



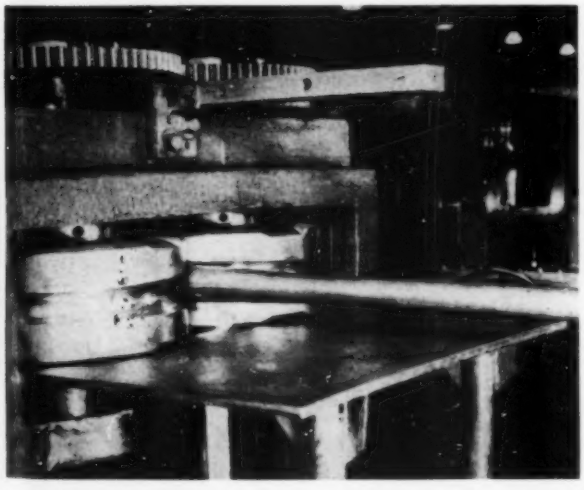
DIES REQUIRE a special machine for grinding and shaping. The grooves are first turned out roughly, as in a lathe, then after hardening are ground to final size by the internal grinding unit mounted on the slide. The machine is fully adjustable for different sizes of dies.



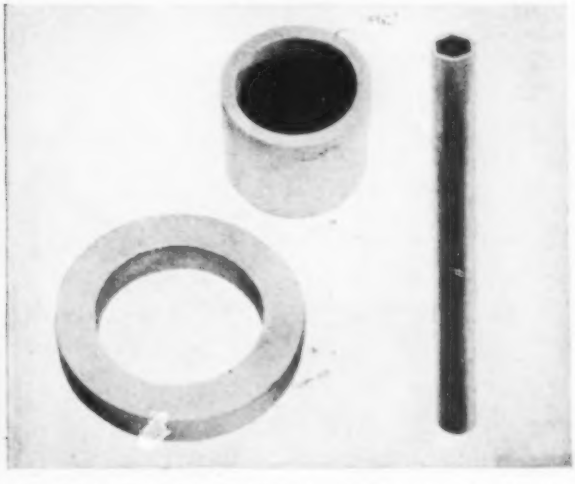
AFTER DIES have been turned and ground, a test specimen of lead tubing is reduced to check the accuracy of the new dies. The soft lead will show up all defects in the newly ground dies and they can be reground to correct any dimensional errors before being installed in the machine.



ELECTRIC MOTOR under the floor drives an eccentric wheel to actuate large linkage at left, which rocks the entire saddle. The saddle is mounted on live axles with rollers which run on hardened and ground steel track. Roller teeth run in a rack. The feeding of the ingoing tube occurs at the end of the backward motion of the saddle. Work is then done on the tube when the saddle is pushed forward, the bottom roll meshing into stationary racks by means of gears. The die rotates in the reverse direction to the saddle, reducing tube in tapered section.



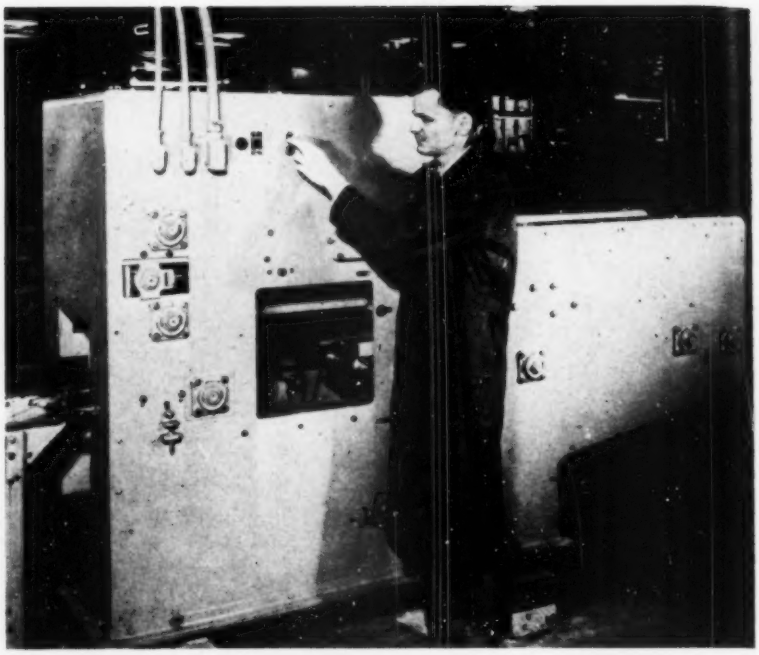
REDUCED TUBES show a fine surface finish. The inside shape can be varied with special mandrel shapes to produce special bores. Bi-metal tubing can be produced by inserting a small tube in a larger one, and then reducing them.



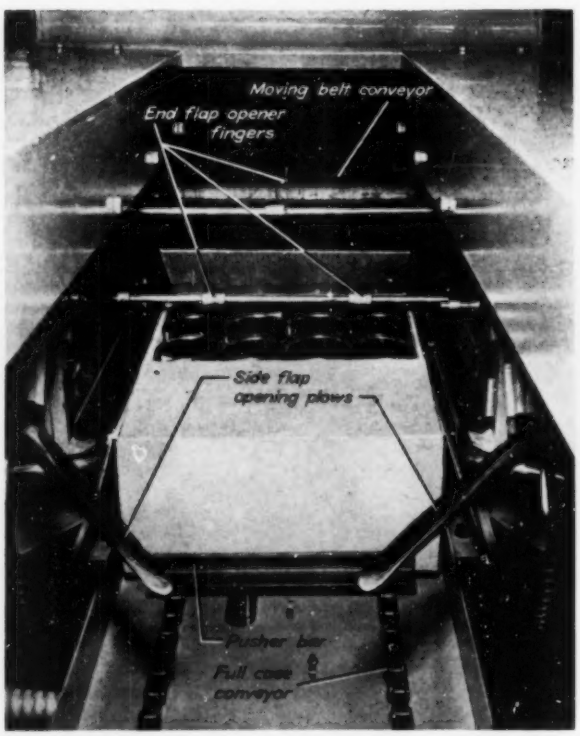
OUTSIDE DIAMETER REDUCTION and wall reduction depend on the material used. The quality and eccentricity of the ingoing tube, the condition of the dies and the feed used will determine final tolerances.

Control System Speeds Unloading

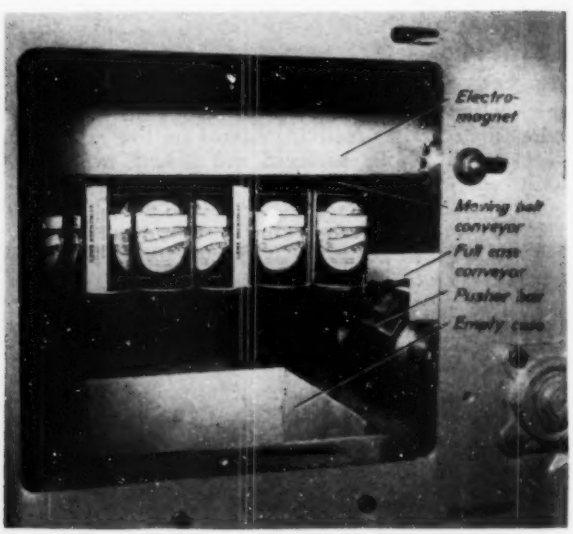
Automatic removal of empty cans from single-depth cases reaches speeds beyond 600 cans per minute with a new can uncaser made by the Bruce Engineering Corp., in San Francisco. One of the most important features of the new machine is the care with which it has been designed to prevent operating failure or jamming. Automatic interlocks and switches stop the machine as soon as trouble develops. If one of the cardboard case flaps does not open correctly, for example, the machine comes to an abrupt stop, and then restarts automatically as soon as the difficulty has been corrected.



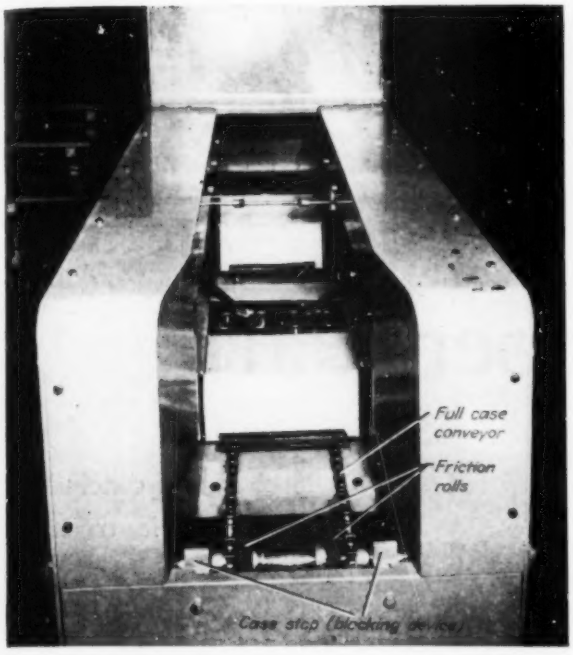
THE FEW MANUAL CONTROLS needed to operate the machine are grouped on one side. The uncasing operation performed by this machine had previously been a hand operation. In addition to the economies of automatic operation, the machine turns out a continuous flow at controlled speed.



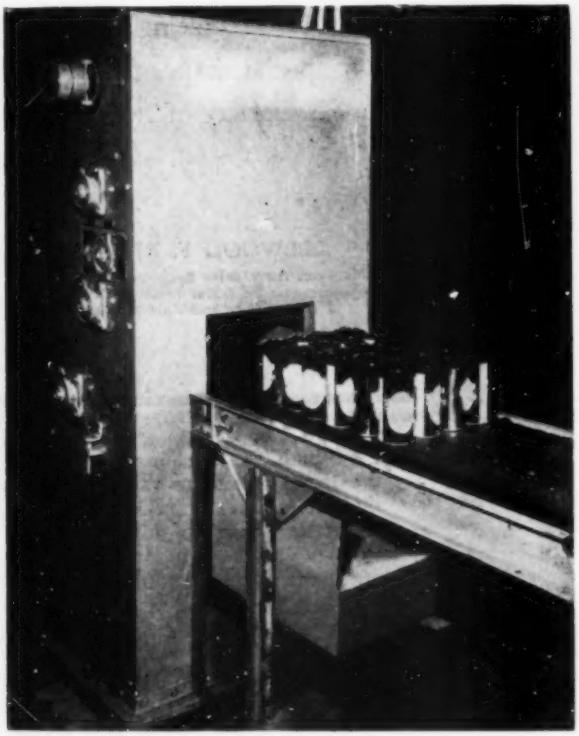
CLOSEUP SHOWS how end flaps are raised. One narrow finger moves down and raises each flap. Two smaller fingers move forward in the same manner, but at a rate exceeding the flight bar. Flaps are held down until they pass belt.



AFTER ALL FLAPS have been opened and folded out, the carton passes under an electromagnet, which attracts the metal cans and holds them in position on the conveyor belt. The case drops free and falls to another conveyor belt, which carries it out of the machine. The cans continue to move ahead, held to the overhead belt by the magnet, until a second belt picks them up from below. The electromagnet operates without interruption, with the cans being disengaged by moving out of the magnetic field. Speeds are up to 27 cases, or 648 cans per minute. Cases and cans travel in a straight line throughout the cycle with no sharp turns in material flow to limit speed or generate shocks.

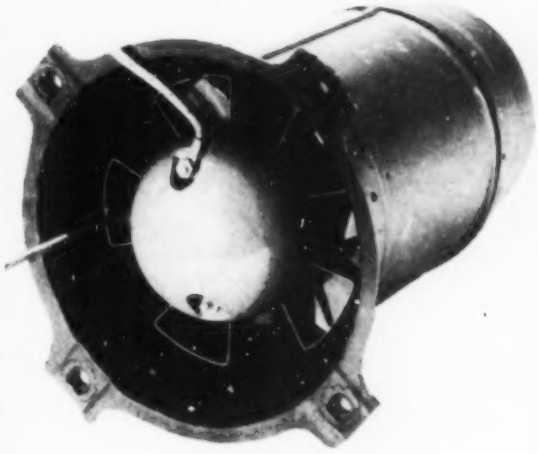


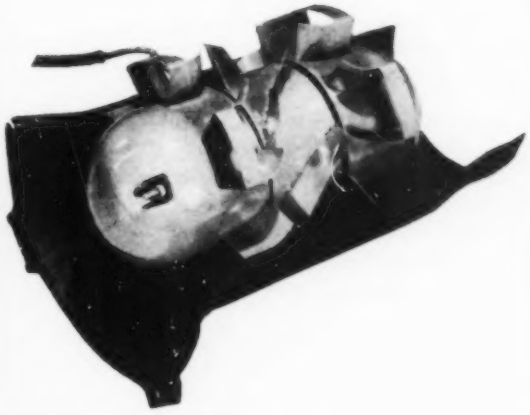
FULL CASES OF EMPTY CANS are fed into machine by a conveyor. A single rubber roller on each side of the case exerts a light pressure to "pop out" the large side flaps. A plow then opens and folds flaps. Fingers raise end flaps.



FINAL PHASE of the cycle ends with case and cans separated, ready to be filled, sealed and recased by other machines. To prevent the machine from coasting ahead and possibly jamming, the motor has a zero speed switch.

Stamped Parts For Axial Blower





WHEN AUTOMOBILE MANUFACTURERS went from the old style heating units to "fresh air ventilation" is was found that the previously used squirrel cage blowers had certain disadvantages. They offer too much resistance to air flow when they are not turning, and are also subject to a supercharging action when the car is driven at high speeds. This supercharging action increases the current consumption of the motor. In view of these points, Hayes Industries, Inc., of Jackson, Mich., redesigned their automotive heating and ventilation system around an axial flow blower. The axial flow fan had less internal restriction, but blowers of this type are usually made of expensive castings with air foil blades, so the company developed a less expensive stamped design. The blades are attached by bent tabs, a construction often used with toys. The tabs are turned in a punch press, and require no welding. Stampings are used throughout, and are formed on presses with roll feeds.

Factors Influencing Design of

Natural and Synthetic Rubber Parts

Second and concluding article in a series covering 15 most important types of elastic polymers. Temperature and hysteresis effects in all of these types are presented in great detail, as well as methods of calculating design of special shapes for a wide variety of stress types.

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Manager, Automotive Engineering and Sales*
Firestone Industrial Products Division
Firestone Tire and Rubber Company

BASIC ELASTOMERS

Natural rubber — a high polymer of isoprene coagulated from the latex of the Hevea tree. Natural rubber is not oil resistant, but it is the best of this group for elements requiring a minimum of energy absorption and long flexing life.

Neoprene — a series of rubber-like synthetic polymers made by polymerizing chloroprene. Neoprene compounds have the desirable characteristic of petroleum-base oil resistance, plus excellent resistance to acids, weathering, ozone, and flame.

Butadiene-styrene — a copolymer of butadiene and styrene, which can be made with varying ratios of each. One specific ratio is identified as Buna S or GR-S (general purpose synthetic rubber). Butadiene-styrene copolymers, like natural rubber, are non-oil-resistant synthetics. Compounds of this elastomer are used in such applications as tires, weather seals, non-oil-resisting gaskets, radiator hose, bumpers, mats, engine and motor mountings.

Butadiene-acrylonitrile — a copolymer of butadiene and acrylonitrile, which can be made with varying ratios of each. One specific ratio is identified as Buna N. The butadiene-acrylonitrile copolymers have excellent resistance to petroleum-base oils and many organic fluids. These compounds are widely used for oil and gasoline hose, tank linings, packings, oil and grease seals and gaskets.

Butyl — a copolymer of isobutylene and small amounts of unsaturated hydrocarbons such as isoprene. Butyl is essentially a non-oil-resistant elastomer; however, it does resist some vegetable oils. It is outstanding for its low rate of gaseous diffusion and is extensively used for automobile-tire inner tubes.

THE EFFECT OF high and low temperatures on the stiffness or modulus of natural and synthetic rubbers cannot be minimized. (See article "Engineering Design with Natural and Synthetic Rubbers," by E. F. Riesing, p 106, November PRODUCT ENGINEERING.) At temperatures of 0 F and lower, some of the elastomers rapidly begin to lose their elasticity, some actually crystallize, and others harden to a point where the material is not serviceable. At temperatures of 158 F and above, aging effects take place more rapidly, and at 212 F and above materially shorten the service life. Both the tension modulus and the Young's modulus values illustrate this temperature influence. Table II shows the change of ultimate tensile strength and the change in elongation at rupture for temperatures of 70, 158 and 212 F for the 15 compounds of the basic elastomers (see Box). The stiffening effect of low temperatures on the Young's modulus of elasticity is shown in Fig. 1. Young's modulus is calculated from the beam formula:

$$E = Wl^3/4bdh$$

where E = Young's modulus, psi, W = load producing a deflection, lb; d = deflection produced by load W,

* *Now Manager, Sales Engineering, Industrial Division, National Motor Bearing Co., Inc.*

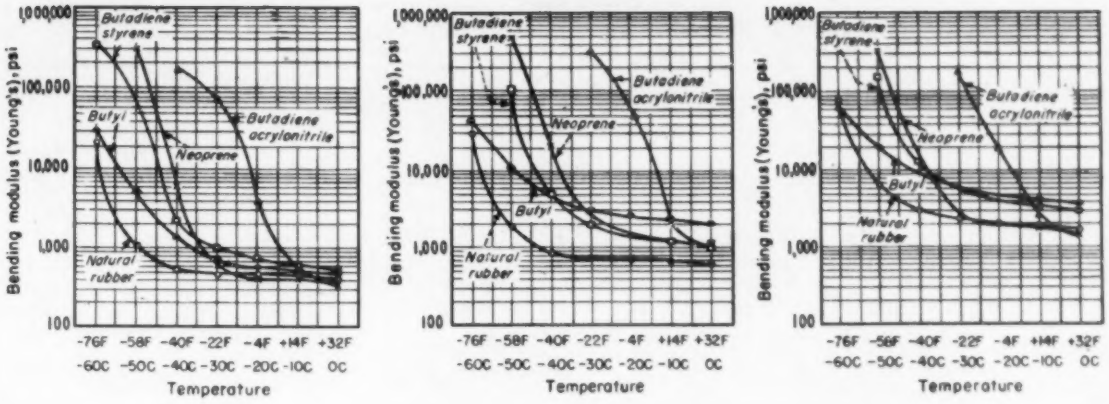
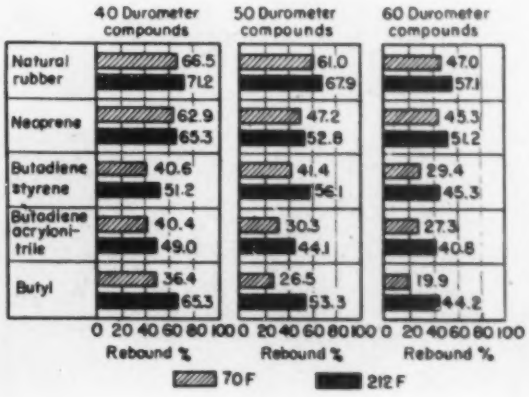


Fig. 1 — Stiffening the effect of low temperature on the modulus of elasticity of (A) 40 durometer, (B) 50 durometer, and (C) 60 durometer rubber stocks.

Table I — Effect of Temperature Change on Tensile Properties at Rupture

Temperature, F	Tensile Properties	Natural Rubber	Neoprene	Butadiene Styrene	Butadiene Acrylonitrile	Butyl
		40 DUROMETER				
212F	Tensile, psi	1500	125	275	475	250
	Elong., %	720	200	275	297	250
158F	Tensile, psi	2400	275	550	625	450
	Elong., %	730	330	400	310	410
70F	Tensile, psi	3075	2800	1525	1325	2400
	Elong., %	690	870	800	460	660
		50 DUROMETER				
212F	Tensile, psi	2125	475	275	400	675
	Elong., %	730	430	300	230	580
158F	Tensile, psi	2850	800	525	575	525
	Elong., %	700	520	420	280	725
70F	Tensile, psi	3650	2175	2050	2200	2975
	Elong., %	640	740	710	510	715
		60 DUROMETER				
212F	Tensile, psi	2225	650	800	1025	1075
	Elong., %	640	320	390	340	595
158F	Tensile, psi	2350	1325	1400	1475	1750
	Elong., %	540	430	520	370	700
70F	Tensile, psi	3450	3275	2850	2250	2725
	Elong., %	610	690	725	410	610

Fig. 2 — The change in impact resilience caused by elevation in temperature from 70F to 212F in the fifteen basic elastomer types.



in.; l = distance between center lines of sample supports, in.; b = width of sample, in.; and h = thickness of sample, inches.

Fig. 2 shows the change in impact resilience values caused by the elevation in temperature from 70 F room temperature to 212 F for the 15 elastomers.

Hysteresis or internal friction of a compounded elastomer is an important factor when considering load-carrying insulators forced through a short-interval resonance period by variable frequency vibrations. Hysteresis, a function of the energy absorbed by the elastomer, can be measured by the area of the "hysteresis loop" of the stress-strain extension-retraction diagram, or by the decay of free vibrations. The hysteresis value varies with temperature and frequency, and differs for every specific compound.

The design of highly functional vibration absorbing elements operating under high frequencies and at elevated or depressed temperatures demands a more complex study of the dynamic properties of the elastomers. For this purpose the Firestone Research organization designed a resonance shear vibrator and a technique for obtaining the two fundamental dynamic properties of natural and synthetic rubber stocks: Dynamic modulus and internal friction. From these properties dynamic service characteristics can be predicted, providing the forces involved in the application are sufficiently determinate. Table II lists typical values obtained with this apparatus.

In these studies the "hysteresis index at constant maximum impressed strain" (internal friction multiplied by frequency) was found to be nearly independent of dynamic shear strain, while the dynamic shear modulus decreased moderately with increasing dynamic

Table II — Hysteretic and Elastic Properties of Compounds of Five Basic Elastomers

Elastomer	Temperature	40 DUROMETER				50 DUROMETER				60 DUROMETER			
		Dynamic Modulus (psi)	Internal Friction (kilopoises)	Relative Energy Absorption		Dynamic Modulus (psi)	Internal Friction (kilopoises)	Relative Energy Absorption		Dynamic Modulus (psi)	Internal Friction (kilopoises)	Relative Energy Absorption	
				Constant Strain	Constant Stress			Constant Strain	Constant Stress			Constant Strain	Constant Stress
Natural Rubber	−4 F	136.0	17.00	293.0	1583	300.0	39.60	682.0	756	Resonance mass too high to measure			
	32 F	85.5	4.70	81.0	1101	137.0	9.40	162.0	861	406.0	23.80	410.0	249
	122 F	62.0	1.26	19.4	504	92.6	1.93	33.2	386	210.0	4.88	84.3	201
	212 F	64.5	0.81	14.0	346	90.4	1.18	20.4	250	170.0	2.51	43.3	150
Neoprene	−4 F	Resonance mass too high to measure				Resonance mass too high to measure				Resonance mass too high to measure			
	32 F	138.3	13.70	236.0	1230	495.0	59.50	1003.0	420	554.0	59.50	1003.0	336
	122 F	76.2	1.72	29.6	510	143.0	4.40	76.0	372	212.5	5.10	88.0	195
	212 F	69.2	1.62	28.0	585	119.6	3.72	64.0	447	175.0	4.05	69.8	228
Buna S	−4 F	Resonance mass too high to measure				Resonance mass too high to measure				Resonance mass too high to measure			
	32 F	295.0	22.30	384.0	441	483.0	32.40	558.0	239	Resonance mass too high to measure			
	122 F	139.5	5.85	101.0	520	163.0	6.25	108.0	407	359.1	14.27	246.1	190
	212 F	70.3	3.00	51.7	1041	99.8	3.02	52.0	520	196.0	7.28	125.7	327
Buna N	−4 F	Resonance mass too high to measure				Resonance mass too high to measure				Resonance mass too high to measure			
	32 F	Resonance mass too high to measure				Resonance mass too high to measure				Resonance mass too high to measure			
	122 F	83.4	4.15	71.5	1003	277.0	14.30	246.2	321	310.2	16.50	276.4	225
	212 F	57.5	2.58	44.5	1345	145.6	7.00	120.6	565	207.0	7.12	150.6	285
Butyl	−4 F	Resonance mass too high to measure				Resonance mass too high to measure				Resonance mass too high to measure			
	32 F	Resonance mass too high to measure				Resonance mass too high to measure				Resonance mass too high to measure			
	122 F	57.5	3.72	64.0	1930	119.6	3.22	55.5	388	388.5	17.85	308.0	204
	212 F	62.2	1.05	18.1	468	120.4	1.02	16.4	328	252.3	7.14	123.2	193

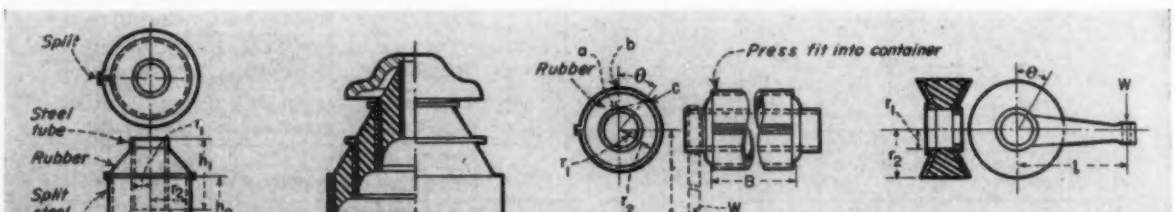


Fig. 3—(A) Cylindrical rubber spring for loading parallel to the longitudinal central line. (B) Three-stage cylindrical rubber spring. Deflection of each stage can be calculated by formula used for shape in (A). (C) Torsional rubber-bonded bushing, in which rubber is bonded to inner and outer concentric metal tubes. (D) Modified torsion spring: A type of torsional bushing.

type stock investigated. Dynamic shear modulus was found to be independent of frequency, and hysteresis index at constant maximum impressed strain only slightly dependent on frequency. This work also brought out the fact that at conditions well above reasonance, energy absorption at constant force is proportional to internal friction divided by the square of the dynamic modulus, and at constant amplitude is proportional to internal friction.

A study of a series of budadiene-styrene stocks of varying ratios revealed that the dynamic moduli of all converged at a single point of 122 F, but were well apart of 212 F. The study of internal frictions of these same compounds showed that the internal friction values converged at 212 F, but were well apart at 122 F. Yet, at both 122 and 212 F, the ball rebound impact resilience values were well apart.

Table III tabulates the results of testing on the Muller Stroking Machine samples compounded in four different basic elastomers in copression and in shear. Although all four of these compounds are of identical durometer hardness, there as a tremendous difference between them in the measurement of hysteresis loss.

Designs of Special Shapes

CYLINDRICAL SPRINGS. A cylindrical rubber spring for loading parallel to the longitudinal centerline is illustrated in Fig. 3(A). Deflection of this type of spring can be calculated from the following formula:

$$d = \frac{W}{2\,G_s}\left(\frac{r_2 - r_1}{h_2 r_1 - h_1 r_2}\right)\log_e\left(\frac{h_2 r_1}{h_1 r_2}\right)$$

where d = deflection, in.; W = load, lb, h_1 = height of bonded area on inside tube, in.; h_2 = height of bonded area on outside tube, in.; r_1 = radius of bonded area on inside tube, in.; r_2 = radius of bonded area

on outside tube, in.; and G_s = modulus of elasticity of rubber in shear, psi.

A three-stage cylindrical rubber spring is shown in Fig. 3(B). Deflection of the separate stages can be calculated by the foregoing formula, the total deflection being the sum of the separate deflections.

TORSIONAL RUBBER-BONDED BUSHINGS. In this design, Fig. 3(C), rubber is bonded to inner and outer tubular concentric metals. The ends of the rubber in these designs should be contoured to relieve concentration of stress at the smallest bonded area, the length of the rubber being greater on the small tube than on the outer. A 3 percent radial compression in the assembly will greatly increase life.

The following formula can be used for design of rubber torsion bushings or springs for ratios of thickness of rubber of shaft diameter of 0.3 to 0.7, see Fig. 3(C):

$$\theta = \frac{Wl}{4\pi BG_s}\left(\frac{1}{r_1^2} - \frac{1}{r_2^2}\right)$$

where Wl = torque, in.-lb; θ = angular deflection, radians; B = effective length of rubber, in.; r_1 = radius of inside bonded area of rubber, in.; r_2 = radius of outside bonded area, in.

Two factors that must be considered in the design of rubber torsion springs are the stress on the bonded area and the strain in the rubber. Referring to Fig. 3(C), for a given angular movement θ of the torsion bushing, the strand of rubber ab becomes approximately ac, and the ratio of stretch to initial length is $(ac - ab)/ab$. From the geometry of the figure,

$$ac = \sqrt{r_1^2 + r_2^2 - 2r_1 r_2 \cos\theta}.$$

If ab is small in proportion to r_1, the strain in the rubber for an angular movement θ will be excessive, even though the stress on the bonded area of the inner metal shell is low. Conversely, if ab is large in proportion to r_1, the strain in the rubber will be low, even though the stress on the bonded area is high. Hence, in the design of these bushings, it is best to limit the strain in the rubber approximately 80 percent and the bond to approximately 110 psi of the area of the inner shaft under normal static loading.

A modified torsion spring is illustrated in Fig. 3(D). The formula for angular deflections in this type of spring is:

$$\theta = \frac{2\,Wlt}{\pi G_s\,(r_2^4 - r_1^4)}$$

where θ = angular deflection, radians; Wl = torque, in.-lb; t = mean thickness of rubber, in.; r_1 = inside radius of rubber, in.; r_2 = outside radius of rubber, in.; and G_s = modulus of elasticity of rubber in shear, psi.

For greater deflections the tangent of the angle θ must be considered, since this function no longer approaches the value of the angle itself. The equation then becomes:

$$Wl = \frac{\pi G_s}{3}\left\{2\left[r_2^3 \tan^{-1}\left(\frac{r_2\theta}{t}\right) - r_1^3 \tan^{-1}\left(\frac{r_1\theta}{t}\right)\right] - \frac{t}{\theta}\left[r_2^2 - r_1^2\right] + \frac{t^3}{\theta^3}\log_e\left[\frac{4 - r_2^2\theta^2}{4 - r_1^2\theta^2}\right]\right\}$$

in which Wl = torque, in.-lb; G_s = shear modulus, psi; t = mean thickness of rubber, in.; r_1 = inside radius, in.; r_2 = outside radius, in.; θ = angular deflection, radians.

Table III — Compression and Shear Tests on Muller Stroking Machine of Four Elastomers (Durometer 40)

	Compression				Shear			
Elastomer	Efficiency percent	Rate lb/in	Energy Absorption ft-lb/min	Hysteresis Loss, lb	Efficiency percent	Rate lb/in	Energy Absorption ft-lb/min	Hysteresis Loss, lb
Nat'l Rbr.	88.0	9,800	165	36.8	81.2	935	143	12.4
Neoprene	83.2	9,550	240	36.8	80.5	1,110	184	19.5
Buna S	57.7	12,500	855	238.0	50.0	1,210	616	60.6
Butyl	60.0	7,870	441	102.0	49.3	877	423	39.0

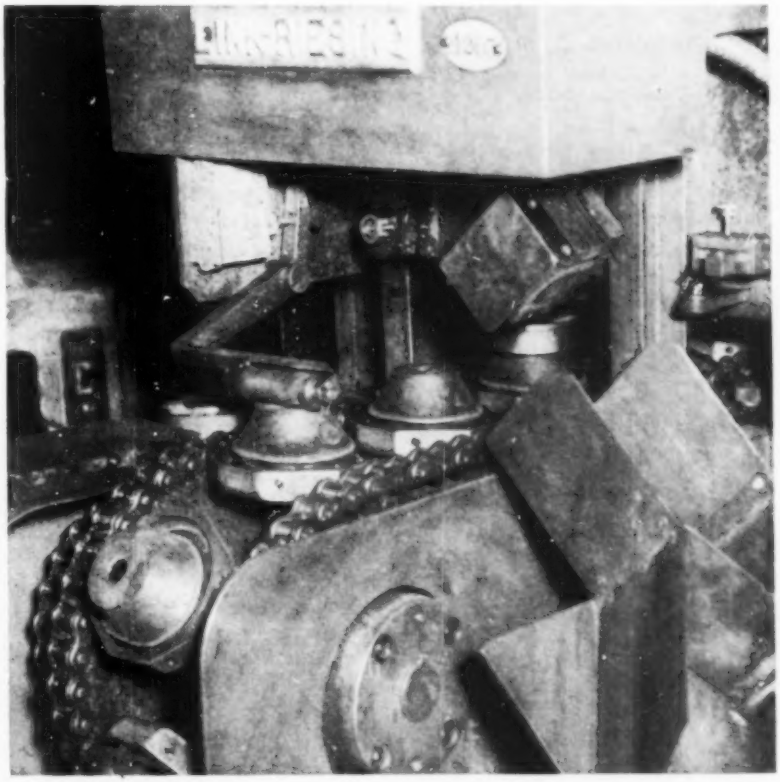


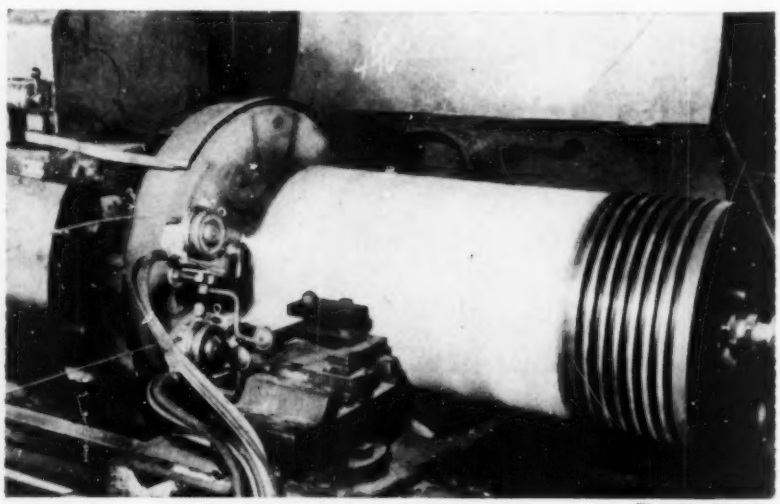
Fig. 4—Link-Riesing machine for production testing of uniformity of modulus of rubber parts. Meeting the shortcomings of surface indentation instruments, this conveyorized machine enables fast and low cost checking a wide range of mountings.

AUTHOR'S NOTE: Appreciation is gratefully extended in the preparation of this article and the previous article (pp 106 to 111, November PRODUCT ENGINEERING) for the efforts of the author's staff engineers and technicians: Messrs. Campanale, Gieck, Hardgrove, Haushalter, Larch, Moore, and Roach. Acknowledgement is also made to the chemists, compounders, and research physicists of the Firestone Tire and Rubber Company.

Metallic Surface Coatings for Gray Iron

CHARLES O. BURGESS
Technical Director,
Gray Iron Founders' Society

Methods of applying metallic coatings to gray iron, for appearance, corrosion, wear or other requirements, include spraying, welding, cementation, diffusion, hard facing, hot dipping, and electroplating. Metallic coatings applied to gray iron include tin, zinc, lead, aluminum, chromium, nickel, copper and alloys of these metals. Choice of material or method depends on optimum balance between cost and desired properties. Because the information on coating processes is so extensive and so rapidly developing, the possibilities of each type of surface treatment and the usual method of application are only outlined.



Thornton Company

Automatic spraying with stainless steel of the gland area of a gray iron hydraulic ram, required to resist 4,500 psi pressure.

Sprayed Metal Coatings

Spraying of molten metal on the surface of base metals enables inexpensive, readily-cast materials, such as gray iron, to be employed in the core or main body of a part, and deposition of another metal on surface areas that must withstand severe wear, extreme corrosion or possess other unique properties. Practically every metal available in wire or powder form, including copper-base alloys, light metals, hard-facing alloys, and many pure metals, has been successfully sprayed. The metal wire or powder is progressively fed into and melted by the oxygen-gas flame of the spray gun, and the small molten globules of metal picked up by a blast of compressed air are deposited on a prepared surface.

One example of this method is the coating of gray iron rolls with stainless steel. A 6,300 lb chill roll for animal fat rendering, equal in efficiency to a solid stainless steel roll, was produced more quickly and less expensively from gray iron by metallizing the roll surface with a $\frac{1}{8}$ in. thick layer of sprayed stainless steel, and other types of sprayed surfaces have been deposited on cast iron rolls as large as 9 ft in diameter.

The same technique is used to coat cast iron beds with hardened steel, bearing surfaces of air compressors with stainless steel where electrolytic action is a factor, and to deposit metals such as lead and aluminum which do not readily alloy or adhere to ferrous metals. Special after-treatments are occasionally employed, such as light shot blasting to densen a lead coating, and reheating aluminum coatings to promote actual alloying with the base metal.

Since the bond between the base metal and the sprayed metal is largely mechanical, one of three processes of surface preparation is necessary prior to spraying:

1. For relatively thin coatings, pressure blasting with sand or grit. If heavier coats are to be applied, a

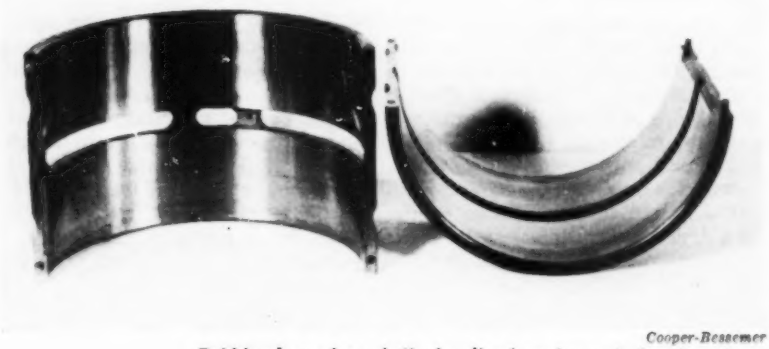
roughing cut is taken, sometimes followed by knurling.

2. An undercoat produced by stroking a series of nickel electrodes across the surface, forming a frothy, shallow layer of nickel.

3. Spraying a self-bonding wire of molybdenum metal, which actually welds to the base iron surface.

One advantage of spraying is its rapidity. While only 3 or 4 lb of metal per hour are deposited by welding, about 20 lb of metal per hour can be applied by spraying. As compared to electroplating or dipping, sprayed metal can be applied to local areas without use of shielding.

While sprayed metals give excellent wear resistance on bearings and packing surfaces, they have limitations for this purpose. The material tends to be porous and consequently, has reduced tensile strength and impact resistance, particularly resistance to point impact. As experience in spray gun operation increases, some of these limitations are minimized.



Cooper-Bessemer

Babbitted cast iron shell of a diesel engine main bearing shows advantageous use of an adherent, continuous coating of tin.

Hot Dipping Processes

Metal coating by hot dipping is particularly adapted for use with gray iron castings. Essentially the process consists in immersion of a clean casting in a molten metal bath. Intricate or complicated casting shapes normally do not constitute a problem, and size is easily controlled by varying time of immersion. Special cleaning processes or use of fluxes are sometimes necessary for optimum results.

TIN (TINNING). This process provides a surface that is highly corrosion resistant, and facilitates assembly by soldering and sweating. The surface layer of tin is also essential in effectively bonding bearing metals to a gray iron or steel base. In addition to a proprietary cleaning process now widely used to prepare gray iron for tinning, several new methods, developed by the British Tin Research Institute, solve previous difficulties associated with tinning gray iron by dipping or wiping. All yield adherent, smooth, continuous coatings similar in quality to hot-dipped tin coatings on mild steel. The "Kolene" process is probably the most common proprietary process, and usually involves immersion of the casting in catalyzed molten salts at 820-950 F, plus a sequence of oxidation and reduction cycles, caused by reversing an imposed electric current between the casting and the steel tank. The effect is to oxidize out graphite flakes and produce a ferrite surface adapted to tinning. The process is also employed in preparing the surface of gray iron for electroplating tin, and for brazing.

The improved tinning methods brought out by the Tin Research Institute of Great Britain also depend on immersing the gray iron casting in fused salts. Both methods prevent former troubles associated with graphite sludge on the iron surface after pickling, and appear superior to older, more expensive methods, which involved electroplating with iron or copper previous to tinning.

Tinned gray iron castings are used in such applications as bearing shells for engines and generators, constituents of soldered assemblies, and operating parts or containers in food processing equipment.

ZINC (GALVANIZING). Zinc coating is one of the commonest methods of protecting ferrous metals. Even though the coating is incomplete, the iron base metal is protected from corrosion until the overlaying zinc and intermediate zinc-iron compounds are consumed. A marked increase in the useful life of a part normally results. Zinc coating (most often by the hot dip process) increases corrosion resistance of castings to ordinary and industrial atmosphere, salt air, and saline, alkaline and other corrosive water solutions. The possibilities of zinc-coated gray iron castings for replacement of comparatively high cost corrosion resistant materials should be explored.

If the galvanized part is exposed to humid or stagnant moisture conditions with limited access of oxygen, there is sometimes a formation of voluminous white corrosion deposits of zinc oxide, which may prevent proper functioning of parts requiring close tolerances. Immersion of the zinc-coated part in an acidified sodium chromate solution inhibits formation of such deposits, and is known as chromate passivation. Other proprietary processes such as the Iridite, Unichrome and recently developed electrolytic process can also be employed. Often the zinc coating is painted; here, chromatizing can be omitted and phosphatizing substituted for better paint adherence.

The primary requirement in galvanizing is a clean surface, and a typical cleaning cycle consists of: (1) Thorough sand blasting or tumbling; (2) pickling at 140-180 F in dilute sulfuric acid (3-8 percent), often followed by a dilute hydrochloric acid pickle; (3) rinsing; and (4) fluxing with fused ammonium and zinc chlorides held either in a separate container or floating on the surface of the molten zinc bath. The cleaned casting is then immersed in the molten zinc bath.

If a number of small castings are being handled, it is customary to spin or centrifuge them in a basket after galvanizing, to throw off any excess zinc. This is followed by quenching in water to improve the luster of the galvanized coating. Control of "pull-out" time determines the desired coating weight on larger castings. Large castings of intricate shape are sometimes warmed by suspending them over the zinc bath to minimize thermal shock.

Zinc coatings can also be applied to gray iron castings by the metal

to gray iron castings by the metal spraying method previously described. However, hot dip galvanizing is frequently the cheapest, good adherence can be obtained, and heavy zinc layers are easily applied.

LEAD AND LEAD-TIN. Lead is more resistant to industrial atmospheres than zinc, and is essential to resist corrosive conditions in certain chemical operations. The temperature of molten lead baths used for coatings are low, usually less than 700 F, minimizing thermal shock and distortion. Despite these facts there has been only a limited application of high lead coatings to gray iron or steel for these reasons: (1) Pure lead does not form a close bond with iron (lack of intermetallic compounds); (2) there is a tendency toward pinhole formation; (3) lead is soft and its resistance to wear and abrasion is low; (4) there is a tendency to form unsightly corrosion products; and (5) lead is slightly cathodic to iron, and if the coating is not complete, corrosion may occur at the expense of the underlying iron.

Some of the adherence difficulties can be overcome by use of a lead bath containing up to 2.5 percent tin and 2.0 percent antimony. An alloy with about 0.55 percent Zn has been used. Such lead alloys are commonly held at bath temperatures of less than 650 F. The hot dip lead-alloy coating thickness on hardware, specified by ASTM A267-46T, varies from 0.15 to 0.51 oz per sq ft (0.00016 to 0.00053 in. thick), depending on the size of the article and whether it is centrifuged. Because of the low wear resistance of lead, heavier coatings of the order of 0.003 to 0.005 in. are desirable, at least if lead is electroplated or sprayed. Use of higher tin-lead coatings, (15-25 percent tin), usually referred to as terne plate, is a possibility if corrosive conditions permit. As tin alloys with both cast iron and lead, it is effective in bonding the high lead coating to the base metal.

A decarburizing treatment with fused nitrate salts or the Kolene process described in the Tinning section is a desirable preparatory step.

Lead coated gray iron castings should be excellently suited for use where high resistance to corrosive atmosphere is the prime necessity, and wear resistance is not required. Such uses would be gasoline tanks, electrical hardware, and farm equipment.

ALUMINUM (ALUMINIZING). Hot-dipped aluminum coatings are valuable in enhancing resistance of gray iron to both corrosion and to high temperature. Low activity aluminum oxide films on coating surfaces renders protection of the base metal less effective unless the coating is continuous. If continuous, such coatings have excellent resistance to the atmosphere, and liquids such as concentrated nitric acid.

Adherent coats of aluminum greatly increase resistance of iron castings to high temperatures and practically eliminates scaling up to approximately 900 C (1650 F). Plans are now underway to commercially adopt manifolds of gray iron treated by hot-dipping in aluminum. Such aluminum coated castings are of potential value as oven linings, muffles, furnace parts in general, heat reflectors and heating element holders. When unusually thick coatings are desired heating of the hot-dipping pieces is effective. It is customary to specify an aluminum weight of 0.5002 oz per sq ft (which for the same thickness is about the same as 1.3 oz per sq ft of zinc).

Expanding uses for coated castings include protection of brake drums from corrosion, and duplex wheels.

Stoody Corporation

Hard-faced cast iron augers, 18 to 24 in. dial, are economical and give abrasion resistance required in this application.

Hard Facing Applications

Application of hard wear-resistant coatings to gray iron castings or other base materials, either by gas welding or arc welding, is particularly valuable if the castings require heavy, adherent surface armor ($\frac{1}{8}$ in. or more), resistant to impact, corrosion wear.

Hard-facing of gray iron is usually resorted to only when: (1) Chilling is considered impractical or impossible because of design, (2) a worn part is being built up, or (3) a special type of wear and/or corrosion resistance is required than can be obtained from a chilled layer.

Hard surfacing permits the use of a comparatively low cost base material such as gray iron. This is true because only the particular surface that must resist abrasion, impact, corrosion or heat need be hard-faced. Hard-facing alloys outwear by 2 to 25 times the usual ferrous materials. Some gray iron castings that have been satisfactorily hard-faced by oxyacetylene and arc processes include crushing rolls, large blades used to mix sand and cement, pulverizer discs, muller tires, augers, pug mill knives, pump castings, conveyor screws and agricultural machinery.

Hard-facing alloys are furnished in rod or tube form to facilitate their deposition by either gas or arc welding. They are divided into four classes: Class I—ferrous alloys with less than 20 percent of alloying elements such as chromium, tungsten, manganese, silicon, carbon, and nickel. Included in this class are steels in which wear resistance is sacrificed for toughness. Some alloy cast irons are also included. Class II—alloys with over 20 percent of alloying elements of the type contained in Class I, generally less tough but harder than the Class I alloys. High carbon, high chromium alloys often with smaller amounts of manganese, and molybdenum, are among the most common

rods in Class II. Class III—nonferrous alloys with typical constituents of chromium, cobalt and tungsten, although special elements such as boron may be present, and nickel may be used instead of or in addition to cobalt. These materials are useful in high temperature applications. Class IV—the so-called diamond substitutes that consist usually of tungsten carbide, although tantalum and titanium carbides, or borides of chromium are sometimes present. All these hard-facing materials can be applied to gray iron, although Class I and II alloys are used most. Of these the high carbon (2 percent or above), high chromium (15-30 percent) alloys have proved most advantageous.

Castings to be hard-faced must be thoroughly cleaned, to remove both surface and impregnated oil, dust and rust. Cleaning is particularly desirable in rebuilding or resurfacing castings that have already been contaminated from being in service.

It is generally recommended that the depth of hard-facing coatings be limited to ¼ in. If a greater surface build-up is necessary, it should be done by using undercoats of a low carbon steel rod, nickel rod, or a rod similar in composition to the base metal.

Although arc welding is usually the most rapid and cheapest deposition method the base metal is exposed to steeper thermal gradients and more decided thermal shock than in gas welding. Several expedients are employed to lessen danger of cracking the base metal, particularly if adequate preheating is not available. Gas welding, as a means of depositing the hard-facing alloys, possesses the advantage that the oxyacetylene flame itself can be used to preheat the areas to be hard-faced and to avoid sharp temperature gradients. This is particularly advantageous when small castings such as certain types of gear teeth must be coated. With larger castings standard preheating precautions should be observed. A much smoother final surface is produced in gas welding than is usually possible using arc welding. It is also possible to readily apply much thinner coatings using the gas method.

Special surfacing alloys, such as the lower melting point bronze alloys, have definite value in building up worn surfaces and furnishing localized corrosion resistance. Because of their low melting point, little difficulty is encountered. However, they cannot be classed as true hard-facing alloys.

Battelle Memorial Institute

Integral structure of chromium "case" on gray iron is produced by salt-bath treatment for 3 hr at 1,035 C (x256).

Cementation Coatings

In cementation processes, as in hot-dipping, an alloying action takes place between the metallic surface layer and the underlying gray iron. Cementation differs, however, from hot-dipping in at least two important respects. First, the use of a molten metal is not required, the casting instead being heated in: (1) A powdered metal, (2) a gaseous atmosphere of volatized metal or its salts, or (3) a fused bath of metal salts. Second, the cementation process consists of a slow diffusion of one metal into another, and the final coating is comparable to the inner or alloy layer of a hot-dipped coating of the same metal.

ALUMINUM (CALORIZING). The calorizing process consists essentially of heating an article in contact with aluminum powder, alumina, and ammonium chloride, to diffusing aluminum into the surface of the base metal and thereby increase its resistance to oxidation at high temperatures. It has been successfully applied to gray irons as well as other metals. However, some gray irons "grow" on repeated heating and cooling will tend to crack-up or "craze" the aluminum-containing skin produced by calorizing. This is followed by oxidation along the lines where the skin has fractured. Many growth-resistant irons contain small amounts of chromium.

A number of variations in the calorizing process have been developed. Typical calorizing mixtures vary from one containing 49 percent aluminum, 49 percent alumina, 2 percent ammonium chloride to a patented mixture containing 70 percent aluminum powder, 23 percent ammonium chloride and 7 percent zinc. Most processes require heating the casting in these mixtures in closed vessels at temperatures varying from 1500 to 1600 F (700-850 C). Heating times vary, depending on the desired depth of penetration—usually about 0.01 in. or less. The important requirement for oxidation resistance is that the outer layers have an aluminum content of at least 9.5 percent.

The main disadvantage of the calorizing process is that articles must be packed in gas-tight retorts, thus limiting the size of the castings and require their treatment previous to assembly.

Calorizing and other methods of producing aluminum-rich coatings can be used to protect containers used in treating metals, and in applications such as heat exchangers. Protection both to high temperatures (up to 1400 F) and substantial resistance to sulfurous gases is claimed.

CHROMIUM (CHROMIZING). Displacement of iron by chromium and diffusion of chromium into the base metal results in integral, non-flaking cases having chromium contents varying from about 35-70 percent at the immediate surface to about 13% chromium at the interface of the case and the base metal. The surface of a casting so treated exhibits the corrosion resistance, wear resistance, and oxidation resistance of a chromium-iron alloy of similar composition. For example, chromized layers as thin as 0.005 mm have shown complete resistance to a 1:2 concentrated nitric acid, water solution at room temperature during several-month tests.

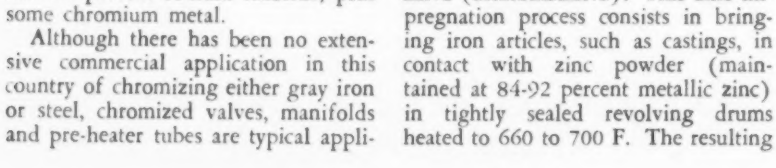
The process involves immersion of

the gray iron casting in a molten bath consisting of 30 percent chromous chloride, 30 percent barium chloride and 21 percent sodium chloride, plus some chromium metal.

Although there has been no extensive commercial application in this country of chromizing either gray iron or steel, chromized valves, manifolds and pre-heater tubes are typical applications in which the process has been found useful in Germany.

ZINC (SHERARDIZING). This zinc impregnation process consists in bringing iron articles, such as castings, in contact with zinc powder (maintained at 84-92 percent metallic zinc) in tightly sealed revolving drums heated to 660 to 700 F. The resulting sherardized or zinc-iron coating has an average iron content of 8 to 10 percent. A coating thickness of about 0.0025 in. is produced in three hours.

The advantage of the sherardizing process is that a uniform coating of zinc or iron-zinc alloy is produced. Threaded parts show no tendency to fill up as in hot-dip galvanizing, and need not be recut after sherardizing.



Cast iron pistons are plated with hard chrome (left) and heavy nickel (center and right) for maximum wear resistance.

Electrodeposited Coatings

To some extent full realization of the inherent possibilities of electroplated castings has been delayed because the best preparatory cleaning methods and optimum plating conditions for electrodepositing a number of metals on gray iron differ from those for steel. Gray iron is being satisfactorily electroplated with most commercial metals, but proper allowance for these differences must be made.

NICKEL. Nickel plates fall into two general classes: Heavy, wear—and corrosion—resistant "hard" plates, and various thinner decorative plates with more limited corrosion resistance.

Hard or heavy nickel plating has become progressively more important in recent years. Originally used for building up worn or mis-machined parts, its toughness, wear resistance, and corrosion resistance have recently led to its use in food processing equipment in railroad equipment, rolls used in paper in textile mills, filter plates, valves and beer pumps. The deposits can be machined or ground, and once in service have a tendency to work-harden while their toughness minimizes danger of plate lifting, cracking or blistering. In comparison with hard-chromium plating (the other heavy industrial plating process), hard nickel deposits are less hard and wear resistant, but are often more practicable because of the greater rate of nickel deposition, which makes it preferable economically. When great hardness and wear resistance are required, a thin layer of chromium (approx. 0.003 in.) can be deposited after a build-up with nickel.

Nickel plating of castings does not present any unusual problems. The same cleaning techniques are often used as for low carbon steel. The most common "hard" bath solution (capable of depositing nickel in the hardness range of 35 to 45 Rockwell C) is that developed by the International Nickel Company. Where less hardness is required, any of the ordinary plating baths may be used to directly plate nickel on gray iron.

Nickel is especially suited for decorative plate because it does not oxidize appreciably in air and because it can be polished to a bright finish. In itself, thin nickel plate offers no galvanic protection to iron and, since it is somewhat porous, corrosion of the base metal underneath the plate is possible. This is very often prevented by first applying a thick layer of copper (usually 0.0005 to 0.0010 in.) to the base metal followed by an equal layer of nickel. Decorative nickel is widely applied to such products as sanitary ware, and stove parts.

Three types of decorative nickel plate can be used on gray iron, depending on the type of bath used in plating. Of these three the oldest now in common use, and the basic nickel solution is the Watts bath. This produces a dull, gray deposit which can, however, be buffed to a bright finish; it can be applied directly to gray iron and operates at a comparatively high speed. This bath is used especially where the brittle qualities of bright nickel plate are undesirable, or with large size castings which cannot be economically given a high polish.

More important in modern industry are the many processes for bright nickel plating. These produce very lustrous, hard, corrosion-resistant coatings which are highly decorative. Furthermore, such coatings impart brightness to a subsequent thin layer of chromium. For this high finish, however, it is absolutely necessary that the metal be carefully polished and free from defects of any kind. Some smoothness is gained by applying, and then highly buffing an initial layer of copper. The most important bright nickel baths are proprietary.

A newer and promising type of plate, also proprietary, is the so-called semi-bright nickel plate. The advantages claimed for solutions of this type are greater toughness and smoothing power than the normal bright nickel solutions. The semi-bright plate is easily buffed to a very bright finish.

CHROMIUM. Thin decorative coatings, as well as heavier, hard, wear resistant coatings, are employed.

The familiar thin, decorative chromium plate is applied over previously deposited layers of copper and nickel, or nickel alone. The resulting finish is comparatively hard, lustrous and highly attractive, and will not tarnish even under severe conditions. The functional value of such plating often goes beyond a simply decorative one, as in chromium-plated sole plates of

electric irons, commonly made with gray iron as the basis metal.

For maximum decorative effect, the nickel undercoat must be as free as possible from imperfections, and as a consequence, this or the original copper coat can also be buffed. The fine, extremely thin chromium coat (about 0.00002 in.) will reproduce exactly the surface on which it is plated.

Heavier, "hard" chromium deposits are commonly applied directly to the gray iron base without intervening copper or nickel undercoats. "Hard" chromium plate is now recognized as one of the most useful of industrial finishes. It has a number of excellent qualities which particularly suit it for use on gray iron. It is extremely hard (Brinell 1000-1025), with a low coefficient of friction, high seizure resistance and, in coatings of sufficient thickness, high resistance to corrosion and to most common industrial reagents, except hydrochloric and sulfuric acids. Despite the comparatively high cost of the process, it is used in such applications as rolls for the paper industry, dies for forming plastics, linings for cast iron bushings, glass manufacturing equipment, rams, plungers, spindles, and automotive parts.

Increased usefulness of plated gray iron automotive and diesel engines results from "porous" chromium plating, which holds the lubricant, and prevents seizing or galling. Using this plate, the life of gray iron cylinder bores and cylinder rings, has been measurably increased. Its application is spreading to other cast products, such as compressors, hydraulic equipment and special tools, where lubrication is critical, or easy release of substances from the plated surface is demanded.

Three methods of applying porous chromium plate to gray iron are in use: The "mechanical" method—hard chromium plating over a roughened, cut, engraved, etched or grit blasted basis metal—and the "pit" and "channel" methods in which the porosity is induced by uneven chemical or electrochemical etching of chromium deposits.

CADMIUM. Many advantages of zinc coatings, such as electrochemical protection against corrosion, can be found in cadmium coatings. In addition, cadmium can be very readily deposited on gray iron castings using either "still" or "barrel" methods. It is more common than zinc plating on gray iron, and offers better protection than zinc to attack by alkalis or marine atmospheres. Cadmium is also preferable for use on castings which are threaded or operate with close tolerances, whereas the unsightly and bulky white corrosion products of zinc may often interfere with the action of a machine. Unfortunately, however, cadmium is more expensive than zinc. However, in view of the economy arising from ease of surface preparation, ease of deposition and finishing the cadmium deposit, it may prove to be the most practicable coating where less expensive metals are now used.

Cadmium will give a satisfactory coat on either rough or machined surfaces, and sand—or shot-blasting usually provides a satisfactory surface, although an acid dip is frequently employed. The value of the cadmium coat, can be enhanced by further finishing of the deposit. The most common finishing procedure is "bright dipping" in solutions of oxidizing agents which impart a lustrous surface.

ZINC. In rural atmospheres and in applications where corrosion resistance and not attractive appearance is the main consideration, zinc is often the most economical plate for gray iron.

Despite the applicability of new zinc electrolytes directly to gray iron, many platers prefer to employ a strike of some other metal, usually cadmium, followed by a build-up of zinc plate.

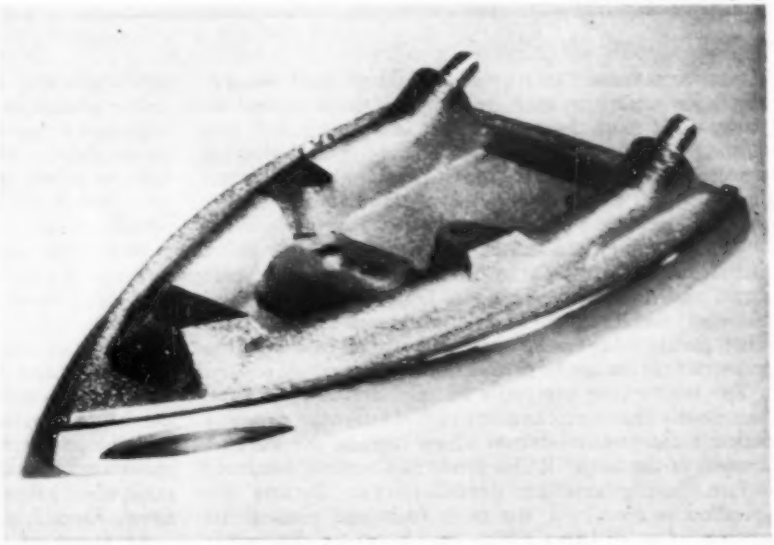
COPPER. Copper plating is widely used as an undercoat in nickel and chromium plating. It is employed as a soft overlay on the base metal since it can be more readily buffed to a high polish, previous to bright plating with other more corrosion resistant metals. There has also been considerable development of "bright" copper plating to facilitate smooth deposits of nickel and chromium. A copper strike or flash is also used as a part of the cleaning or preparatory cycle for electroplating. In itself copper plating is rarely used as a final covering plate because of its tendency to develop unsightly corrosion products.

TIN. Where thin, very uniform coats or heavier coats than can be produced in hot-dipping are desired, or where an oddly shaped casting or one with deep recesses cannot be successfully hot-tinned, gray iron is electrotinned. Such applications include dairy appliances, kitchen surfaces, and where it is adequate, it is one of the cheapest and most readily available of bearing metals. Electrotinning can facilitate "break-in" of piston rings.

OTHER ELECTRODEPOSITED METALS. Lead plating as a protective coating for gray iron has not been extensively employed because it does not give as good atmospheric protection as the more readily available zinc and cadmium plates. A limited use had been found, however, in containers for dilute sulfuric acid and other corrosive liquids. Other applications include lead plating of bearing surfaces. Electrodeposited lead is less porous than a hot dipped lead coating.

Many desirable qualities of metallic deposits can be improved by the deposition of two or more metals at the same time. The commonest types of alloy plates produced at present are brass, bronze, lead-tin, tin-zinc, and nickel-cobalt.

Gray iron sole plate for an electric iron is chromium plated for wear and heat resistance, as well as for decorative effect.
General Electric Company



Advantages of Cold-Drawn Pinions

Fine pitch pinions always have been difficult to produce accurately and in production quantities. But lately the cold drawing process has been making large gains. Reasons: (1) Greater load carrying capacity, wear resistance, and durability of pinion rods produced in this way, and (2) cost economies of the cold drawing process.

ELBRIDGE H. RATHBONE
President, The Rathbone Corporation

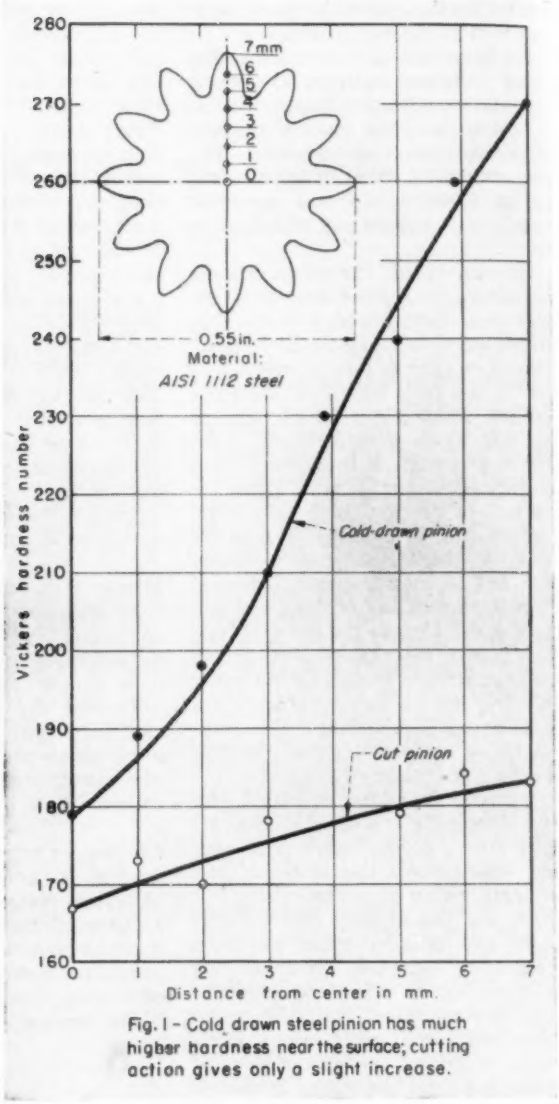


Fig. 1 – Cold drawn steel pinion has much higher hardness near the surface; cutting action gives only a slight increase.

THERE ARE THREE METHODS of making small pinions, namely, by cutting the teeth, by extruding to the finished diameters and tooth forms and by cold drawing rods into finished pinion rod. If the metal has good cold working properties, the last process produces pinions of the highest durability and load carrying capacity, and to an accuracy equal or better than cut teeth.

Whereas pinion rod can be extruded only in the softer non-ferrous metals such as bronze and aluminum, cold drawn pinion rods can be made of high carbon steel, stainless steel, nickel, silver, Monel, sterling silver, and many other metals. Any metal which has good cold working properties can be used for cold drawn pinions.

The outstanding properties of cold drawn pinion rod stem mainly from two factors: (1) Cold drawing produces desirable compressive stresses which increase the working strength of the teeth. It also produces a smooth, hardened surface, having excellent durability. (2) Because the operation is done cold, the tooth form and dimensional accuracy of cold drawn pinion rod is greater than when the pinion rod is made by the hot extrusion process.

The amount of cold working to which a given material is subjected determines not only the skin hardness of the pinion rod, but also the depth of the case, the hardness at different points in the cross-section, and the density of the grain structure. To establish factual data, four 12-tooth pinions of 14 mm outside diameter were tested. These pinions were made of different materials and by different methods as follows: (1) Cold drawn out of AISI 1112 Steel. (2) Same identical material but the teeth produced by cutting. (3) Cold drawn from commercial phosphor bronze. (4) Same material but the teeth produced by cutting. A brass extruded rod 14 mm outside diameter but with no teeth cut into it was also tested to determine relative hardness values. This rod does not give a direct comparison with gears but the results of the test give a good indication of what might be expected from extruded pinion stock when proper allowances are made for differences in material and shape.

By means of a Vickers pyramid diamond tester, the

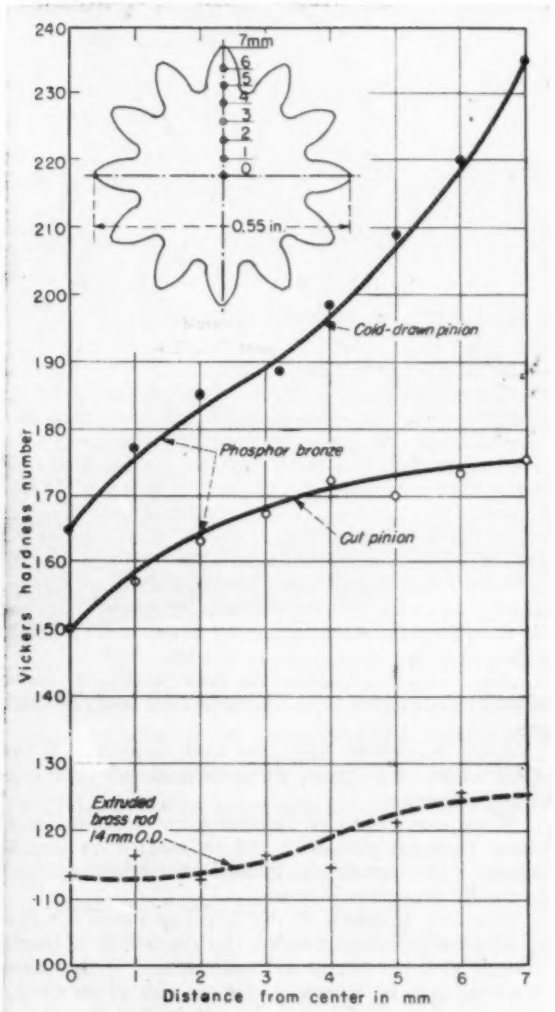


Fig. 2 – Phosphor bronze can readily be drawn with large increase in hardness near the periphery as compared to the center

hardness over the cross section of the pinions and the extruded brass bar was measured at various distances from the center. The readings obtained give the relative differences between the hardness of the cold drawn pinion rod as compared with cut teeth pinions of the same material, and also as compared with extruded brass bar stock.

The graph in Fig. 1 shows the comparison between small steel pinions that were cold-drawn and similar pinions that were cut. Note that the hardness of the cold drawn steel pinion increased approximately 50 percent from the center to the periphery, while in the cut pinion the difference in hardness between the center and near the outer surface was only 9 percent. The slight increase in hardness at the surface of the cut pinion was developed by the small amount of cold working produced by the cutting operation.

Similarly, the bronze cold drawn pinion showed a hardness 40 percent greater near the surface than at the center, whereas, in the cut bronze pinion the difference was only 17 percent. This is graphically shown in Fig. 2. It is interesting to note that the skin hardness of the bronze pinion compares favorably with that of spring bronze.

Based upon the hardness numbers, the tensile strength of the steel pinion at its outer surface was approximately 126,500 psi, which is quite high for AISI 1112 steel. The hardness of the cut pinion near its outer surface indicated a tensile strength of 85,000 psi, which is normal for this type of steel. From this, it is evident that the strength of the cold drawn steel pinion is greatly increased by the cold working of the material.

By virtue of the properties developed by the cold drawing operations, the durability of pinions made from cold drawn pinion rods is considerably greater than the durability of cut pinions. Tests were conducted to establish data on the relative durability of such pinions.

Pinions used in these tests were enlarged to avoid undercut up to the working depth and conformed to American Standard B6-7-1950 (20 deg Involute Fine-Pitch System). Both the cut and the cold drawn pinions were subjected to the same applied load, which was equal to the calculated pinion strength of the tooth. In both tests the pinion engaged the same hardened driven gear which was approximately 2 in. pitch diameter. No lubrication was used during the test. The frequency of stress was at the rate of approximately 100 stress cycles per sec., and varied slightly with the contact ratio between the pinion and the driven hardened gear. Because the pinion rod as drawn has no hole in it, both the drawn and the cut pinion were mounted so that their pitch circles ran true with the axis of rotation. This precaution eliminated the influence of run-out which would have effected wear.

Table I—Comparative Durability of Cold Drawn and Cut Pinions

Material	Diametral Pitch	No. of Teeth	Pitch Dia., in.	Tooth to Tooth Composite Error, in.	Number of stress cycles*		Gain in Durability of Cold-drawn Pinion, percent
					Cut Pinion	Drawn Pinion	
Hard Phosphor Bronze	100	15	0.15	0.0005	2,100,000	4,500,000	214
	60	21	0.35	0.0005	2,960,000	6,200,000	210
Brass	32	16	0.50	0.0003	4,200,000	9,100,000	217
AISI 1113 steel	100	15	0.15	0.0003	4,100,000	8,310,000	203
	80	20	0.25	0.0003	4,300,000	9,080,000	214
	32	18	0.56	0.0003	4,010,000	12,850,000	320

* Stress cycles required to produce an average of 0.001 in. wear on tooth surfaces; based on 10 tests.

The results of the durability tests on six different pinions are given in Table I. Two types of pinions were made of hard phosphor bronze, one of brass, and three of AISI 1113 steel. For each of the six types of pinions, ten cut pinions were tested, and ten pinions produced by cold drawing were tested. In each test, the number of stress cycles required to produce 0.001 in. of wear on tooth thickness was determined. As shown by the table, the durability gain of the cold drawn pinion over the cut pinion was more than 200 percent. In one instance the gain was more than 300 percent. Admittedly, these tests are not conclusive because only a limited number of pinions and materials were tested. But there is every indication that additional test data would show essentially the same results.

Undoubtedly, in addition to the greater skin hardness of the cold drawn pinion, the quality of the surface finish has considerable effect on the life. The average surface finish obtained on cold drawn rod will range between 10 and 30 micro-in. rms. This compares with a surface finish ranging between 40 and 100 micro-in. rms for cut pinions,

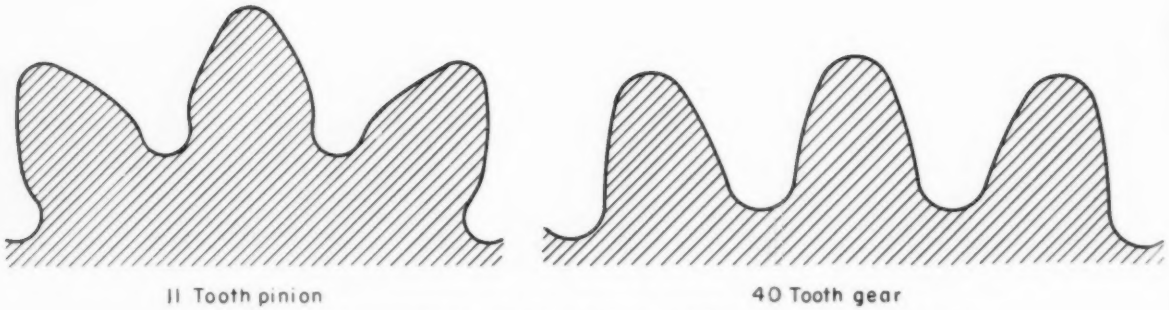


Fig. 3—Correct tooth proportions for cold drawing require full radius at the tip and at the root.

the degree of finish depending on the cutting process and the speeds and feeds used. The following table gives a comparison of dimensional accuracy of cold drawn pinion rod as compared to cut pinions.

Measurement	Pinion rod is:
(a) Tooth profile variation	equal to or better than cut pinions.
(b) Tooth to tooth composite error	equal to cut pinions
(c) Size variation over measuring wires	will average better than cut pinions
(d) Surface finish	better than cut pinions.
(e) Uniformity in a given lot	better than cut pinions.

To summarize the advantages of cold drawn pinions over cut pinions:

1. For large quantity production, cold drawn pinions are cheaper.

2. Cold drawn pinions are stronger and more wear resistant.

3. Greater uniformity of structure because a poor material cannot be cold drawn.

4. Greater uniformity of size and shape, because the process of cold drawing is continuous. One coil of stock converted into pinions represents a large quantity of finished parts, hence inspection costs can be reduced to a minimum.

5. Greater versatility. The process is adaptable to all kinds of toothed wheels including ratchets, sectors, cam shaped gears and various types of non-circular gears. Some of these non-circular types such as elliptical and cam gears are usually costly to produce since they cannot always be manufactured by generating methods.

6. Low tool write off. The cost of tooling for producing cold drawn pinion rod is generally much lower than that of the tools used in gear generating equipment.

The proper design of tooth forms best adapted to cold drawing has not received the attention it deserves. While it is possible to produce almost any tooth form desired, some shapes have better "draw balance" than others.

Experience has shown that almost all gears and pinions of involute form can be produced with slight modifications to adapt them to the drawing process. Following are a few basic considerations when designing a gear train suitable for manufacturing as cold drawn shapes:

1. Avoid all sharp corners. As shown in Fig. 3, round off the top lands of the teeth and the bottom lands of tooth spaces.

2. Avoid excessively thin deep teeth, especially if the material of which the gears are to be made has poor cold drawing properties.

3. When using teeth of involute form, avoid undercut pinions. Undercut pinions should be avoided on general principles, regardless of the method of production, since they usually prove troublesome.

4. American Standard 20 deg Involute Fine-Pitch System, B6-7-1950 is recommended. It is generally advisable to consult with the pinion rod manufacturer if the shape of the teeth is to be otherwise. He can also advise on the selection of the material to make certain that it will not only meet the application requirements, but will be suitable for the drawing operation.

Researchers Finding Many New Uses for Lithium

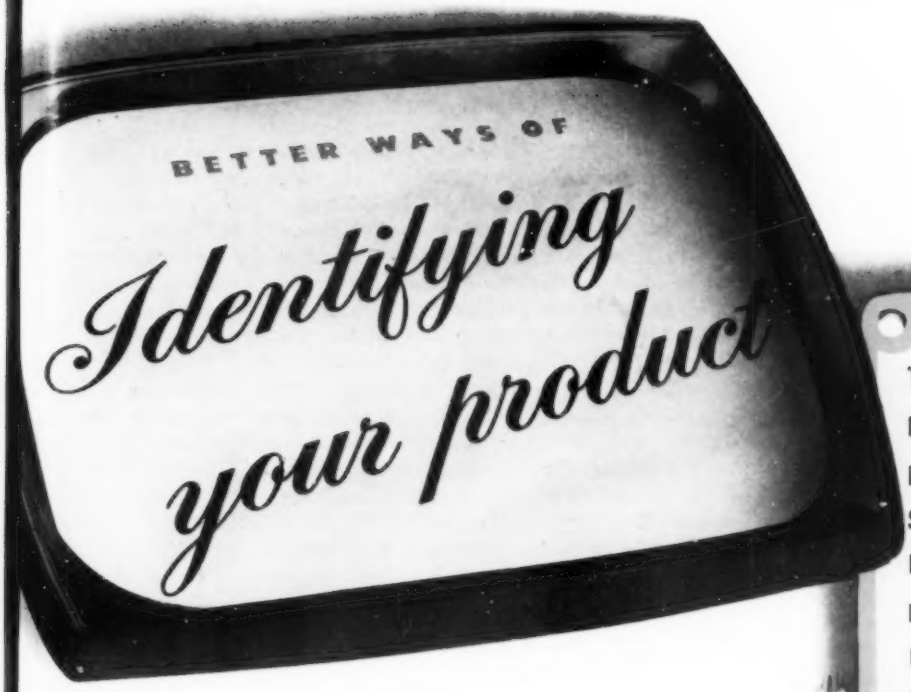
Once a useless curiosity among the metallic elements, lithium has stepped into the limelight in making the so-called hydrogen bomb. The construction of a practical superbomb may rest on lithium's characteristic of capturing bombarding neutrons, and forming atoms of tritium. But even without any help from the atomic program, lithium's new-found popularity with industrial researchers will snowball in years ahead. It is already widely used in castings, porcelain and air conditioning.

Lithium, including its several compounds, is a peculiar element. It has unconventional and unstable characteristics that make it useful in many different jobs. It is the lightest of all the elements—even light enough to float on oil—yet has a high tensile strength. When mixed with water, lithium hydride, a metallic compound, gives off an abundant volume of hydrogen.

Metallic lithium helps to make better, stronger castings for nonferrous founders. A few minutes before a casting is poured into a mold, a pinch of the metal is thrown into the heat as a refining agent. Lithium is so chemically active that it combines with such impurities as gases and oxides in the molten metal. Then, because of their lightweight, the lithium compounds float to the surface and are skimmed off. The result is a casting with a finer grain and less porosity.

Steel makers are putting lithium's affinity for gases to work. A vapor of lithium can prevent scale formation and eliminate costly cleaning or pickling. Heat treating or annealing furnaces for the steel are equipped with a vapor generator. Heat-carrying gas flowing over the generator causes a small cartridge of lithium to vaporize and picks up the vapor on its way to the furnace.

Lithium chloride and bromide salt have been a boon to air-conditioner makers. In a conventinal conditioning system, air is drawn through a tank holding the salt in solution. Other uses for lithium derivatives include welding fluxes, low temperature greases, plastics, special glasses and many nonferrous casting alloys.



- Three Dimensional Plastics
- Decalcomanias
- Die Castings
- Stamped and Etched Forms
- Plastic Moldings
- Integral Sand Castings
- Lithographed Stampings
- Embossed Sheet Metal
- Multiple Colored Metals
- Quality Forgings
- Porcelain Enameled Members
- Skeleton Forms
- Electroplated Stampings
- Castings

The designer who specifies a nameplate, escutcheon or instruction plate as an after-thought makes a serious error. Such components can be used to add color to the design, attract customer attention, and increase product sales.

A comprehensive full-color report on contemporary methods and processes for better product identification. Specialized articles will follow in subsequent issues.

EDWIN DREWITZ
Design Consultant

THE reasons for an attractive identification plate on either an industrial or consumer product are first, it identifies the manufacturer and distinguishes his product from that of a competitor; many successful product designs testify to the fact that identification plates can be accentuated by proper treatment to become a center of interest with definite powers to advertise and sell. Secondly, it can be used to supply the user with model and serial numbers; amperage, voltage, or horsepower ratings; patent notices; and other pertinent information necessary for the proper operation of the equipment.

Contemporary identification means either blend in with the overall design theme of the product, become an integral part of the equipment, or serve as the focal point of the design. These may take one or more of the following forms:

1. Name plates, which include trade names, trade marks, and other identifying designs.
2. Instruction plates, which usually carry the manufacturer's address and the equipment ratings.
3. Scale plates which include calculator dials, computors, indicators, and meter and clock faces.
4. Control knobs, such as oven, radio and TV, automatic washer, and thermostat controls, which may be marked with the manufacturer's name or trade mark. Although these items are primarily functional members, they can be designed to help identify the product.
5. Escutcheons, which may take many forms and carry not only insignia or trade names, but in the case of consumer products, may also be used as a structural member of the product itself.

Cast Identification Forms

Cast identification plates can be made by either of two processes: Sand or plaster castings; or die casting. The former methods are generally low production processes and are used most frequently when a small number of parts are required, while the latter is a fast, high production process that can be used to economically and accurately duplicate parts in large quantities. The name plate may be cast integrally with the product, or made separately and later attached to it. An advantage of specifying integral identification is that designs, letters and numerals can be combined, without much additional cost, on the product, and can later be stamped with individual model and serial numbers. Even if the stamped characters should be ground or filed away by fraudulent individuals, they can still be restored.

On a sand or plaster casting, it is usually immaterial whether the characters are raised or depressed because of the simple nature of the patterns and the negligible destructive effect of the molten metal on the molds. Individual plates are generally cast with raised nomenclature and a raised border. They often are chosen for heavy capital goods because their sturdy appearance compliments the character of the equipment they identify. Integrally cast designs may feature either raised or depressed characters, depending on the design theme or other appearance considerations.

The one limitation to sand casting, besides the previously mentioned one of low productivity, is the detail that can be obtained on small characters and designs. On the other hand, this is one of the major advantages of a die casting in addition to the fact that many duplicate cavities can be gated together in a single die to produce a number of parts in one cycle.

Die cast emblems and forms are used in the automotive industry, and in other mass production industries such as household appliance and machine tool as well. Zinc is a widely used base metal, although aluminum also is commonly specified; magnesium, copper, tin, and lead are seldom used for nameplates either because of cost, castability, or limitation on finishing.

Many interesting finishes and combinations of finishes can be applied to both sand and die cast forms. Raised characters and designs are often painted to contrast with depressed backgrounds. Another interesting and economical contrast is achieved by applying a dark organic finish to the nameplate or escutcheon and then buffing off the tops of the raised surfaces on a fine emery wheel after the finish has dried. This is especially effective with aluminum castings because of the silvery quality of that metal.

Depressed letters and numerals also are often filled with paint to

Porcelain enameled nameplates, emblems, and instrument and telephone dials. Porcelain has excellent resistance to abrasion and weathering. Horrace B. Whittier Co.

Coined and stamped metal name plates with polished or electroplated finishes, some with baked lacquer enamels and vitreous (cloisonné) enamels. American Emblem Company

contrast with the equipment. Large, deep characters, however, may be painted the same color as the background without sacrificing legibility due to the shadow effect of the intaglio characters. In some instances, plated designs are used against a colored background; this provides an effective contrast and paint applied in recesses is more or less protected against abrasion and wear in service.

Electroplated die castings are very common, especially for the automotive industry. Etching is usually confined to stamped or forged forms, as are most of the inorganic finishes.

Stamped Forms

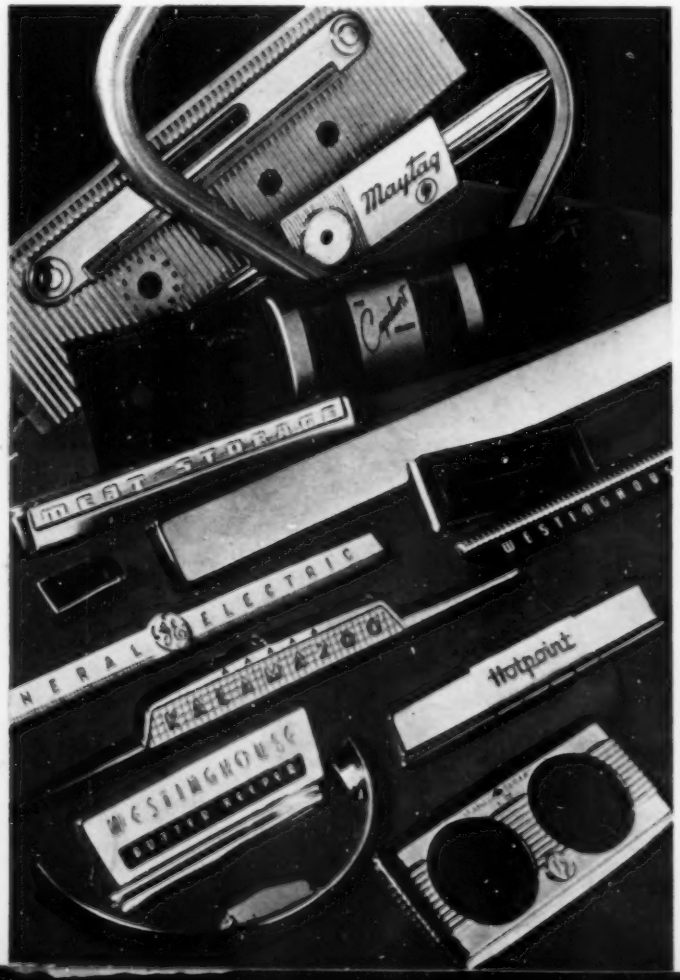
Die stamped nameplates may be the flat, or wraparound interconnected "cut out" type, the die struck type, the popular but slightly more expensive embossed sheet metal type, or the coined type. "Cut out," refers to a blanked, interconnected and usually open-letter type of nameplate that is commonly used for company names, trade names, or slogans. Script, because of its already connected nature, is an ideal medium for this form of identification, and all type styles, even handwriting, can be duplicated. Gothic, Roman or other block letters must be provided with a connecting means unless they are to be individually attached. A single bar, either at the top or bottom of the characters, or a complete border can be used. However, since many company names and trade marks are already incorporated as part of a theme, this does not require the appearance of the mark to be altered.

All the conventional sheet metals—steel, aluminum, brass, copper, monel, stainless steel or others—can be used for this method of identification. Size and thickness limits, of course, depend on press capacities. Interconnected metal nameplates are usually employed individually and may be bright chrome or nickel plated to contrast with colored backgrounds.

Embossed, sheet metal nameplates may have figures, characters or designs in either relief or intaglio, and on first glance, almost appear to be castings because of their depth of character and seeming great strength. Embossing is often used to advantage when combined integrally with a light structural past. When integrated in this manner, the embossed areas serve to rigidize and otherwise strengthen thin, sheet metal units and assemblies. Doors and storage bins for modern household appliances are perfect mediums for light, embossed identification and structural combinations.

The third form of identification that may be produced on the power press is the impressed, die struck type. These are produced by a sharp blow with a hardened steel punch that leaves a flat, intaglio design of uniform depth. The

Stamped and embossed forms for television and household appliances. The bluish colored strip center is an anodized aluminum refrigerator strip. L. F. Grammes & Sons

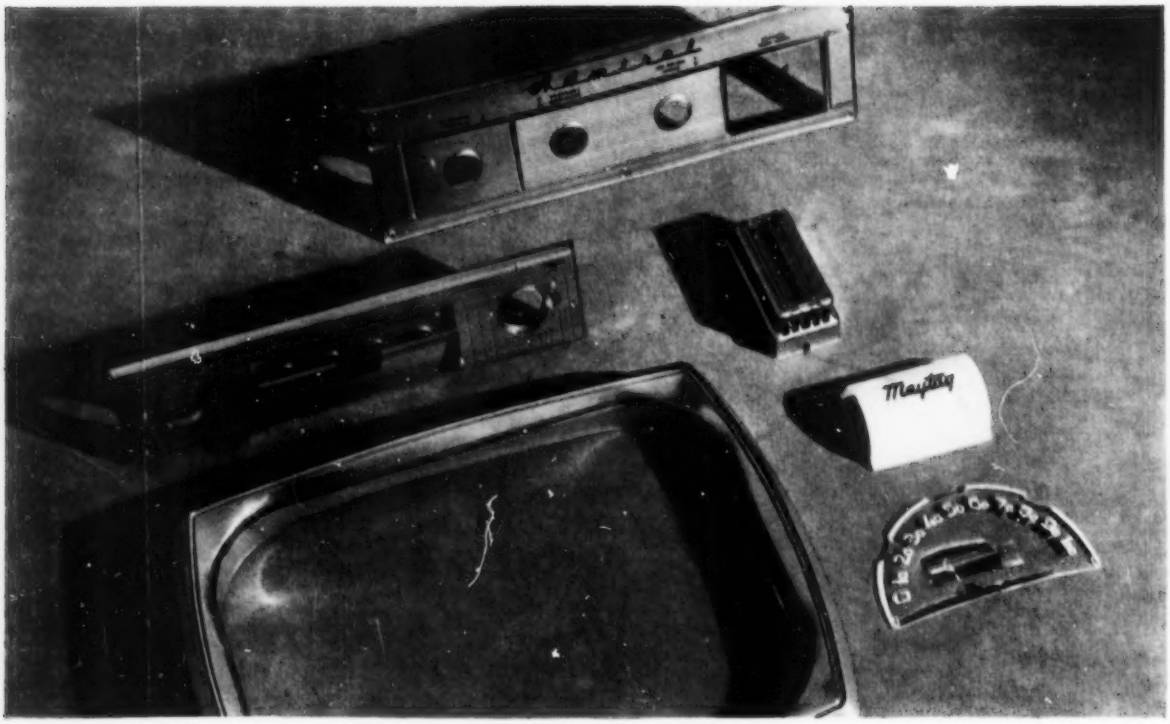


Etched sheet metal nameplates made of aluminum, stainless steel, zinc, brass, and bronze. Such types are both economical and attractive. Etching Company of America

MANUFACTURING PROCESSES AND FINISHES FOR NAMEPLATES

MANUFACTURING PROCESS	MATERIALS USUALLY USED	FINISHES	MANUFACTURING AND FINISHING PROCEDURE
Sand and Plaster Mold Casting	Nonferrous alloys; Brass, bronze, aluminum and magnesium on occasion. Also cast iron for sand castings.	Primarily organic finishes. Frequently raised characters are buffed to obtain a metallic finish against a dark painted background. See also, "Non-Metallic Finishes for Gray-Iron," Product Engineering, October, 1950	Castings made in plaster or sand molds using only casting pressure. Types of finishes and manufacturing procedure not as flexible as for sheet metal forms.
Die Casting	Usually zinc, aluminum, or magnesium, although latter is seldom used for nameplates.	Plating is common, with chromium being widely applied; some gold plating done on high quality nameplates and emblems. Organic finishes also very common.	Conventional pressure die casting process. Finishing usually done on an automatic high production scale. Very high quality finishes can be obtained.
Die Striking	Any metal surface	Since die striking is selected primarily for unobtrusive markings, such markings are almost always done on unfinished or plated metals. However, depressed characters formed by the punch may be filled with paint to secure a better contrast.	Produced by a sharp blow with a punch. No female die required as for embossed plates. Punches can be combined with automatic numbering heads to number the product.
Cold Forging	Steel, magnesium, aluminum and copper. Brass is very popular for nameplates.	Electroplates, paints, lacquers, mechanical finishes, and porcelain enamel in a wide variety of combinations.	Die forging, followed by suitable trimming and finishing operations after proper surface pre-treatment.
Stamping	Sheet metal of any type, including steel, stainless steel, aluminum, brass, copper and Monel.	Same as forgings for blanked or embossed plates. Also, lithographed or etched plates, the etched plates being painted and the lithographed plates being printed.	BLANKED OR EMBOSSED—May be flat, skeleton, or embossed sheet metal type. Embossed types may have figures, characters or designs either in relief or intaglio.
			ETCHED SHEET—Design exposed to zinc plate with light sensitive surface, which then is used to print on sheet metal form. Etching of sheet metal follows, and plate is painted.
			LITHOGRAPHED SHEET—Preparation of drawings, reproduction on master printing plate, and printing on sheet essentially same as for etched plates except that no provision is made on the drawings for color separation. Colors are printed, not painted.
Fabricated plastic forms	Transparent or opaque thermosetting or thermoplastic materials. (Laminated engraving sheet and graphic sheet widely used.)	Most surfaces are printed, painted, or left in their natural state.	Engraving, etching, printing, stenciling, laminating, branding, or embossing. Electroplates can be applied to plastics, although they seldom are.
Molded plastic forms	Both thermosetting and thermoplastic materials.	Painted or natural finish of the plastic, which can be transparent or colored opaque.	Standard molding processes, plus painting; or double or triple injection molded forms in several colors; or acrylic plastic with painted backs to give three dimensional effects.
Decalcomanias	Standard decals are paper with an adhesive backing. Vitreous decals also are available, as are aluminum foil "Metal-Cals."	Printed in any color and with color overlays.	Decal is slid off paper backing and is attached to surface by adhesive backing. Decal is lacquered so it is unnecessary to give it another coat on application to the product.

ADVANTAGES AND LIMITATIONS	APPLICATIONS	REMARKS
Low production processes. Detail not as good as die casting, although plaster cast plates are sharper than those produced by sand casting. Sand casting ideal when identification is cast integral with machine.	Nameplates for large equipment where only limited production is anticipated. Seldom used for consumer goods.	Either raised or depressed lettering can be used. Individual plates are generally cast with raised nomenclature and border. Produces a very substantial appearance.
High production process. Script or block nameplates, with characters connected by bar or border running through characters is excellent. Can be made integral with product or as separate plate. Excellent detail. Dies can be made to produce several plates in one casting cycle.	Automobiles, household appliances, radio and television receivers, office equipment, industrial equipment, when high quality and large production justifies tooling required.	Provides excellent detail. Raised letters on depressed background less costly than depressed letters. Characters should not be undercut to facilitate easier removal from the die. Plates can be cast in one plane or in curved or V-form, although dies for the latter are more costly.
Probably the most economical method of identifying a product. Not particularly attractive and not an attention focusing form. Since characters are formed in the product, however, they will last as long as the product.	Hand tools, cooking utensils, fuse links, thermostatic bimetals, and other parts on which an unobtrusive marking is required; or parts too small to be marked in any other way.	Detail is good. Trademarks or company initials often marked in this way. Method also can be used on sand, plaster mold, or die cast parts when there is no danger of the impact from the punch fracturing the base metal.
Nameplates made in this manner are solid, high quality items. Cost is higher than some of the stamped forms.	High quality nameplates and emblems for industrial equipment, automotive trim, and other devices when moderately high production and solid appearance is essential.	Detail is sharp. Forged identification can be made a part of the product, although separate plates are more common.
Low cost, high production. Almost unlimited design freedom. Any type of finish practical that is adaptable to the base metal. Size limited only by press capacities.	Process is used mostly for name and identification plates. Embossed sheet metal plates combine relief with light weight. All types of industrial and consumer equipment.	Embossing often applied to structural or decorative members, with name identification made a part of the design. Freezer doors and storage bins for household refrigerators are examples.
No tooling cost except for final blanking of the sheet into individual plates. Excellent reproduction of drawing. Low cost. Wide variety of colors and designs. However, different colors must be separated by a raised metal barrier.	Etched plates are ideal for control accessories that are subject to extensive handling because paints lie protected in depressed etched areas. Also widely used for instruction and nameplates.	Metal or plated-metal border prevents paint from chipping on blanking operation. If border is impossible, plate should be blanked with the bottom side up. Lettering may be produced in either depressed or relief forms.
Economical. Can be reproduced as faithfully as any printed matter. Different colors can be printed adjacent to, or superimposed over, one another. Adaptable to both medium and large production quantities.	For name, instruction or scale plates on indoor equipment. Does not resist abrasion as well as other forms. Semi-permanent.	Plates with open designs usually given a brushed satin mechanical finish prior to printing to conceal surface imperfections. Brushed treatment also decreases light reflections, increases plate legibility. Aluminum is widely used for litho plates, but almost any sheet metal is adaptable.
Slightly more costly than sheet metal forms. Good contrast. Wide variety of finishing processes can be used. Various colors can be obtained in the sheet. Have permanence, and will withstand wear and abuse.	Wiring diagrams, instrument panels, plotting boards, fluorescent scales, dials, and nameplates. Engraved graphic sheets usually used when quantities are small or similar types of plates are to have slightly different markings.	Translucent engraving stock can be used with rear illumination to obtain high contrast letters and markings. Sheet can also be obtained in various designs, as for example, wood graining.
Can be molded in several colors by multiple shot process. Acrylic plastics, painted on back in single or multiple colors, gives a beautiful three-dimensional effect. Adaptable to high production. Fairly high in cost.	Automobile insignia, radio and television control panels, and other consumer products. As yet, seldom applied to industrial equipment.	Metallic roll leaf, fused to the back of clear plastic, is particularly effective when gold or silver are reproduced. Additional cost of three-dimensional molded forms usually justified because of their eye-arresting appeal.
Complete freedom of design and coloring possible with lithographed printing process. Can be applied to almost any type of surface including wrinkle, or crackle organic finishes: ceramics, porcelain, rubber, glass, plastic or metal. No fastening devices required.	Unlimited use in consumer and industrial fields when cost is a factor and maximum in appearance not required. Wiring diagrams, name or trademark identification, operating instructions. etc.	Equipment ratings can be inserted as a separate transfer in combination with the regular marking. Providing a shallow nest or depression for the decal will protect it in service and provide a convenient painting guide for future reconditioning of the equipment.



Molded styrene control panels, escutcheon, and dial. The small Admiral control panels are painted two colors on the reverse side. The Maytag stove control panel is painted three colors on the reverse; all other parts are painted in one color. These represent the newer type at three dimensional plastic forms. Amos Molded Plastics

punch somewhat resembles an embossing punch except that it has sharp cutting edges, similar to the familiar hand numbering sets. Unlike embossing no mating, female die is required for this process.

Die struck designs, because of their economy and permanence, are used to great advantage on such mass production items as can and bottle openers, hand tools, or other products such as cooking utensils, that call for permanent but unobtrusive identification marks. Parts too small to carry another form of label or others that are accurately calibrated, such as fuse links or thermostatic bimetals for instance, are also naturals for die striking. Punches of this type can also be combined with automatic numbering heads when such variables as model numbers, serial numbers or inspection dates are required.

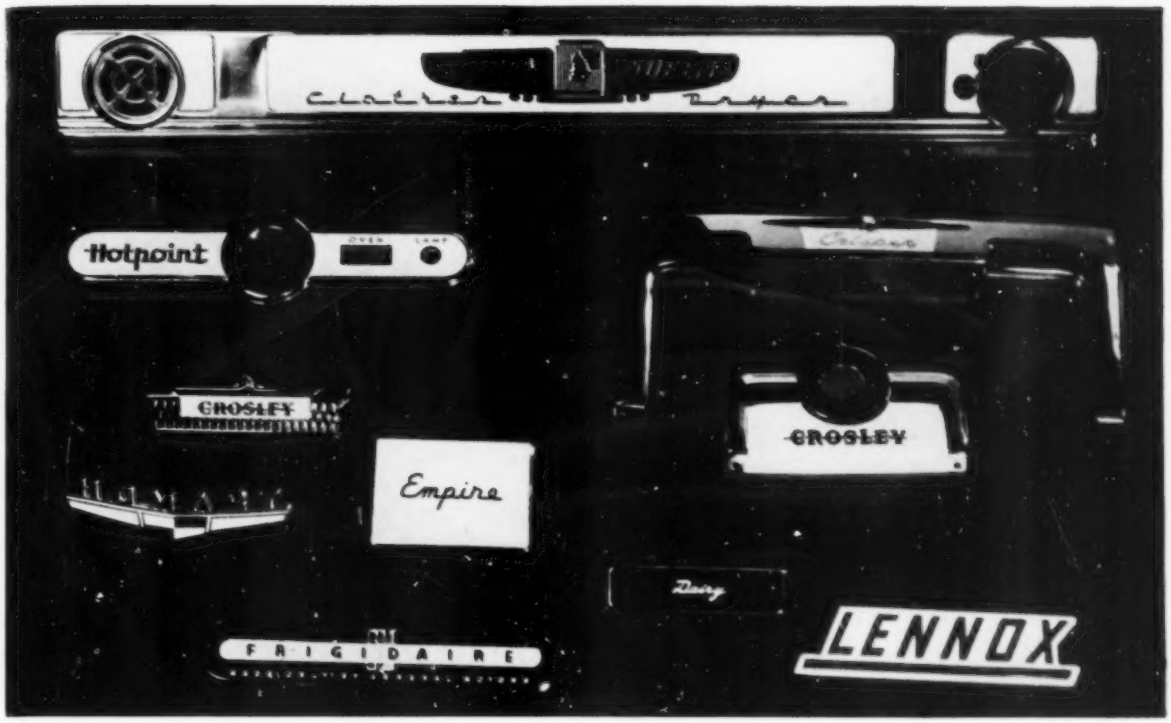
Cold forged or coined forms are used when ruggedness and sharp detail are required. Both steel and brass are widely used for identification forms, brass being far more common because better die life is obtained. Although there are not many manufacturers specializing in the production of such plates, their products are strictly in the high quality category, and are often specified for heavy industrial equipment and quality consumer products.

Etched Nameplates

Acid etching of metals is reminiscent of both offset lithography and the etched, half tone plates of letterpress printing. The three major identity classifications, name, instruction and scale plates, may be produced in almost unlimited variety by this process without resorting to tooling, except for blanking the form out of the sheet strip. Etched plates also possess excellent resistance to abrasion because the paints lie 0.002 to 0.005 in. below the surface, within the etched areas. Except for the necessity of providing means to separate individual colors when more than one color is used in a design, this process reproduces most art work as faithfuly as the lithographic printing process.

Entire sheets, having many plates, are processed. Paints are applied by masking and spraying; both air drying or baking enamels may be used. All manner of color combinations can be achieved, but each color must be separated from the other by a relief portion in the design. Often single colors are used in combination with either the original metal finish or plated highlights with striking results. Excessive paint on the indented metal surfaces is removed chemically along with the protective, acid resistant film as a final step.

Finished sheets are cut into single width strips for either power press blanking or shear trimming. A metal or plated metal border should always be incorporated into the design to prevent the paint from chipping during the blanking operation. However, when calculator dials or other graduated plates that are designed to register with graduations on a mating member cannot be provided with a protective border, they should always be blanked with the burr side up. This protects the paints when they are required at the outer edges by transferring the impact of the blanking punch to the reverse side of the plate.



A clean and sparkling appearance is obtained with chromium-plated letters over a while enamel background for escutcheons, control panels, and nameplates for household appliances. Two variations shown are white enamel characters over a plated background, and gold plated characters in relief on a plated background. D. L. Auld Company

Lithographed Stampings

Lithographing on metal is probably the most economical method of producing high quality nameplates in either large or small quantities. While it may be argued that lithographed nameplates do not resist abrasion and thus are only semi-permanent, this should be no deterrent for most indoor applications. When used on indoor equipment, lithographed plates are generally regarded as having a longer life expectancy than the products they serve. Also on the credit side of the ledger is the fact that lithographed identification means can be reproduced as faithfully as any printed matter. Different colors can be imprinted adjacent or even superimposed over one another.

Preparation of black and white art work, similar to the drawings used for acid etching, but without provisions for color separation, is the initial production step. The drawing is reduced, transferred to a master printing plate and imprinted on the sheet metal surface in essentially the same manner as the pre-etch stages of the etching process. This makes litho a perfect medium for the designer, allowing him to create freely without the restrictions of color separation.

Finishes for Metallic Forms

A discussion of metallic nameplates would be far from complete without at least some mention of the finishes that can be used and the effects that can be obtained. The four classes of finishes that usually are specified are electroplates, paints and lacquers, mechanical, porcelain enamel, and electrolytic and chemical finishes.

Electroplates—Chromium, silver, gold, nickel, and copper or brass are frequently used for either decorative effects or as the complete finish. A wide variety of attractive effects can be obtained by using plated nameplates and trim against a colored or white enameled background (above), or plating the border and name and using a dark organic finish for the background.

Chemical and Electrolytic Finishes—Electrolytic coloring processes, such as anodizing, are not too well adapted to nameplates or escutcheons, the reason being that the cost is fairly high compared to other methods of finishing, and the process is more limited than other methods. Even so, some quality plates are being made in this way.

This, of course, does not apply to the acid etching process previously discussed, which is used in conjunction with other finishes for all types of stamped sheet and forged forms.

Organic Finishes—The organic finishes such as paint, enamel, and lacquer, are especially well suited for final finishes on identification plates. According to the American Emblem Company, the secret in the finishing process is the proper design of the stencils or masks used to separate colors, and the basic design of the plate, since stop-off lines that simply separate finishes and colors can be incorporated in the metal form to decrease labor cost and improve the sharpness of the edging.

Porcelain and Vitreous Enameled Parts—Porcelain enamel for protection, decoration, or identification is an excellent finish when exceptional resistance to corrosion, abrasion, weathering and all around

permanence are desired. There are no limitations to colors or the number of colors that may be combined in a given design. Bold, single-colored characters, such as those used on street and subway signs, are usually applied with stencils or masks. By means of vitreous decals or silk screen stencils, all manner of intricate, multicolored designs can be reproduced.

Elaborate porcelain emblems are produced by applying oxides in etched or other relief metal areas and fusing the nameplate or dial at appropriate temperatures. As a final step, the entire surface is buffed to give a high lustre to the metal portions.

(1) Porcelain enamel has the electrical insulating properties of glass which makes it valuable in electrical construction. (2) The smooth surface of porcelain enamel can be etched. That makes it possible to furnish emblems which have had one section treated in this way so that temporary reading can be applied by user. (3) Porcelain enameled signs can be furnished in any single color or combination of same making it possible to produce extremely attractive appearing items. (4) Porcelain enamel resists heat up to 800 F. This very valuable property makes it necessary to use this material where other products would be affected by heat. (5) Designs and reading matter can be put on porcelain enameled products either by the off-set printing or by stencils.

These remarkable features have found an expanding outlet in kitchenware, refrigerators, gas and electric ranges, food processing machinery, chemical and hospital equipment, outdoor signs and architectural facings.

Plastic Forms

Plastic identification plates may either be fabricated or molded. Casting, a third method whereby metal or other objects are embedded in clear plastic, has only found limited applications to date. Fabricated nameplates, dials, and scales can be produced from either transparent or opaque, thermosetting or thermoplastic sheet by engraving, etching, printing, stenciling, laminating, branding, or embossing. Such plates are usually designed as individual components, but all the aforementioned processes, except laminating may also be utilized to decorate plastic members.

Large wiring diagrams, instrument panels, charts, plotting boards, fluorescent scales and dials and nameplates, of course, are typical applications of the laminated graphic form of identification.

Engraved, laminated plates are used to best advantage when relatively small quantities are involved or where similar types of plates may have slightly different markings. Electrical switch and panelboards are a particularly good example, for such specialized and usually "tailored made" equipment requires proper identification of each circuit and control component with generally no two plates being alike. When markings are uniform and the quantities are large enough to absorb the set-up costs of printing, for instance, or certain tools that may be required, any of the other following processes may be considered advantageously.

One of the most glamorous forms of product identification yet achieved is the comparatively recent plastic molded, three dimensional type of nameplate. These parts are particularly striking in their appearance because they create an interesting illusion of depth and richness by presenting colored characters, designs, or indicia that appear to be suspended individually in a solid, transparent body. They are molded of clear plastic material, usually Lucite or Plexiglas, with designs on the rear surface that appear in relief when viewed from the front. These areas are then made to assume their independent forms by coloring them with paint. Form fitting masks and plugs are used to shield the recessed areas while the backgrounds are sprayed. After these have dried sufficiently, the masks are removed and the entire rear surface is coated with a contrasting color or colors, that will be visible only in the relief areas. These then appear to constitute the exterior surfaces of a solid object.

Decalcomanias

"Decal" transfers are characterized by a deceptively homogenous nature which makes them appear to be painted to the surface they adorn. This resemblance is by no means coincidental, however, for decals actually are a paint job in themselves, consisting of films of paint or ink in several layers on a removable paper packing.

"Slide-off decals" are the most familiar type of transfer and these are produced briefly as follows. An adhesive is first printed, in the outline of the finished design, on a water soluble coated, absorbent paper. Several opaque undercoats are then printed over this for strength, followed by the various colors of the design itself. A protective film of clear lacquer is coated over the design as a last step. Application merely requires the paper backing to be released, in water, from the film of pigments which is slid off, film side up, onto the article to be decorated. The adhesive, with a little pressure, assures a permanent bond.

Decals are available for adhesion to many varied surfaces, including coarse crinkle finishes, plastics, rubber, and fabrics. Vitreous decals are fired and fused to ceramics, porcelain, and glass. Another interesting variation are the new aluminum foil, "Metal-Cals". These resemble an exceptionally thin metal nameplate, but are unlike in that they are secured by adhesives.

Data, such as mechanical and electrical ratings, which may vary from machine to machine, may be inserted as a separate transfer in combination with the trademark.

ACKNOWLEDGEMENT

PRODUCT ENGINEERING thanks the following concerns for their help in assembling illustrations for this article, and in supplying detailed data on various identification forms: Croname, Inc.; D. L. Auld Co.; Bastian Brothers Co.; American Nameplate and Manufacturing Co.; Anderson & Sons, Inc.; The Palm Brothers Decalcomania Co.; Amos Molded Plastics; Kurz-Kasch, Inc.; The Etching Company of America; L. F. Grammes & Sons; New Jersey Zinc Company; Horace R. Whittier Co.; The Master Etching Corporation, and Ingram-Richardson Manufacturing Company.

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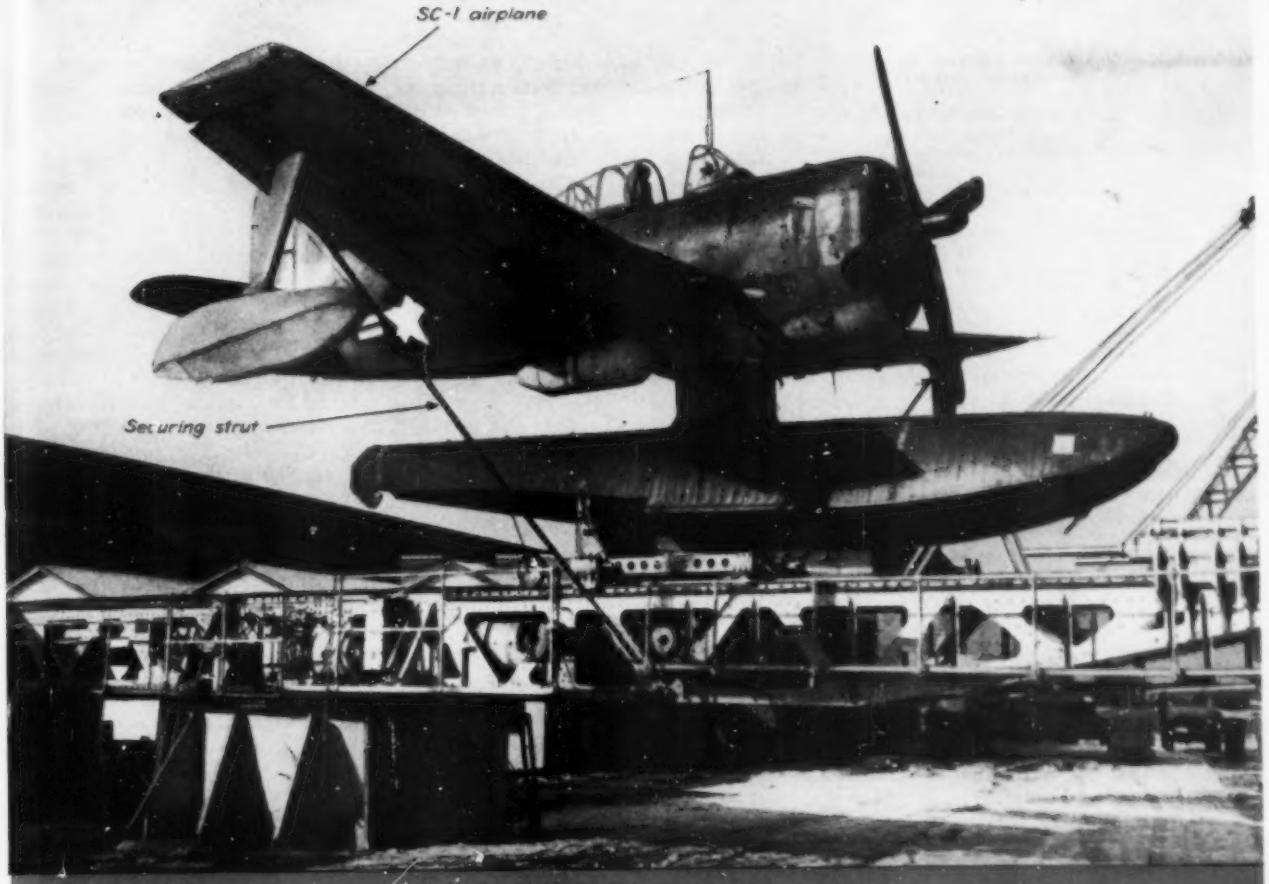


One of the severest shock absorber applications is found on airplane catapults. Catapult used to launch the Navy scout plane incorporates two buffers—one mounted on the launching car, the other fixed to catapult structure. Catapult is operated by a powder charge.

Further Principles of BUFFER DESIGN

JOSEPH BROWN*
Engineer, Naval Aircraft Factory Philadelphia

IN A PREVIOUS article, PRODUCT ENGINEERING, November 1950, page 156, the author discussed the performance characteristics of various buffer types. Also, formulas were presented that analyzed the hydraulic phenomena that occur within a buffer at impact.

After selection of the buffer-type that best fits the application, the engineer is faced with the problem of designing the buffer itself. The main factors in buffer design are the peak pressure of the liquid or gas, which determines the stresses to be withstood by the buffer structure; length of piston stroke; and orifice area. These factors establish the rate of deceleration of the moving body. Since piston travel is usually fixed by the amount of space available for installation of the buffer, fluid pressure and orifice area are the unknowns to be solved for the equations applicable to the buffer type selected.

* *The opinions and assertations contained herein are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Dept. or the Naval Service at large.*

Hydraulic Buffer Formulas

The following are the symbols employed:

a = total orifice area, sq. in.
A = piston area, sq. in.
C = orifice discharge coefficient (average value)
d_c = diameter of cylinder, in.

D = piston diameter, in.
D_o = piston diameter at start of travel, in.
E = energy absorbed by fluid, ft lb
f = acceleration, fps²
F = force on piston, lb
g = acceleration due to gravity, fps²
p = pressure, psi
s = piston travel from start, in.
s_{max} = full stroke of piston, in.
v = velocity of piston, fps
V = velocity of fluid, fps
W = weight of body to be slowed, lb
γ = density of fluid in cylinder, lb/cu ft

The following formulas assume the existance of no friction or other retarding force except the hydraulic back pressure caused by the orifices. The other forces are negligible in most cases. The hydraulic buffer formulas are derived from these basic relationships:

Bernoulli's theorem: $144p/\gamma = c^2V^2/2g$ (1)

Continuity equation: $V = Av/a$ (2)

$p = c^2 \gamma A^2 v^2/(a^2 2g)$ from equations (1) and (2) (3)

and $F = Ap = c^2 \gamma A^2 v^2/(2a^2 g)$

Energy Equation: $-Wdv/v = \dfrac{\gamma c^2 A^2 ds}{3456\, a^2}$ (4)

Constant Orifice Buffer. When the orifice of the buffer is constant in area, Eq (4) may be integrated to give the following formula:

$$\log_e \frac{v}{v_o} = \frac{-\gamma c^2 A^2 s}{3{,}456\, a^2 W} \quad (5)$$

The above formula indicates that v can equal zero only when s equals infinity. This may be surprising in light of the fact that most standard buffers stop the motion in a finite distance. The buffer spear will theoretically bottom, although if v is small enough, bottoming will be prevented by friction alone. The magnitude of v can be made as small as desired merely by adjusting the size of the orifice area. Also, it should be evident from Eq (5), which has been derived free of approximating assumptions, that the velocity of the piston is predetermined for any point along the stroke. It is wrong to assume a velocity variation other than that described by this equation.

The constant orifice design results in the highest liquid pressures of any of the buffers discussed. It should be used only in light, inexpensive devices, where the high initial deceleration can be tolerated and the high pressures do not result in excessive weight for the small mechanisms.

Constant Deceleration Buffers. There are many cases in which a constant deceleration buffer may result in higher reactions than one in which the deceleration will vary to a slight extent. This is true where deceleration is held constant from the very instant of impact. In such buffers, peak loads may occur that are double those resulting from a gradually applied deceleration. It is therefore advisable to add to the constant deceleration stroke a small introductory stroke which will gradually increase the deceleration from a relatively small magnitude to the desired value. The equation for the area of the orifice at any point along the stroke is:

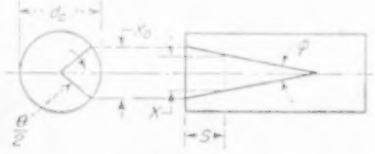
$$a^2 = (v_o^2 - 2fs/12)\, \frac{\gamma^2 c^2 A^2}{288 f W} \quad (6)$$

$$p = F/A = \frac{Wf}{gA} \quad (7)$$

Constant deceleration buffers are the most expensive of the hydraulic buffers due to the care required in securing the proper orifice contour. Moreover, they will not produce constant deceleration if the weight of the body to be stopped is altered, although if the design speed is changed, constant deceleration will still be effected.

Equations For Approximately Constant Deceleration Buffers. For a given length of stroke, these buffers are subject to higher pressures than constant deceleration buffers. However, they are cheaper to manufacture and will serve the purpose as well. The lower cost of an approximately constant deceleration buffer is due to the fact that fewer points along the orifice contour are established by engineering calculations. Hence, less precise machining is required. On the other hand, the orifice contour of a constant deceleration buffer is exactly determined and machined accordingly.

Tapered Slot Orifice



If the slot has a constant depth and the width is defined by the relationship

$(X_o - X)/s = k$ where

$$\frac{k}{2} = \tan \frac{\phi}{2}$$

then the velocity variation will be

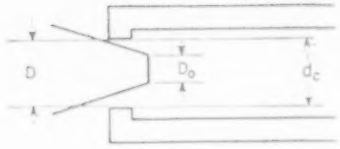
$$W \log_e \frac{v}{v_o} = \frac{\gamma C^2 A^2}{13{,}824 d_c k\,(tn)^2} \times \left[-\operatorname{Cos} \frac{\theta}{2} \right]$$

$$-\frac{\theta}{2} + \frac{(\theta/2)^3}{3|3} - \frac{(\theta/2)^5}{5|5} + - + \ldots \Big]_{\theta_o}^{\theta} \quad (8)$$

where n = number of slots
t = depth of slot
θ = angle of slot (radians)

In brief, the procedure followed in designing this type buffer is as follows. By use of the constant deceleration Eq (5), the orifice area at the start or mouth end of the tapered slot is determined. The area obtained thereby must be increased slightly because the average tapered slot orifice is slightly shorter than a constant deceleration type orifice. The mouth area and the length of the cylinder establish the slot contour, so that angle ϕ can be found. For various values of s, the values of θ and a can be calculated from geometrical relationships. Substitution of the values of θ in Eq (8) yields the corresponding v values. Then, Eq (3) can be solved for the magnitudes of pressure.

Orifice formed by conical rod sliding in fixed diameter hole. If $(D\text{-}D_o)/2s = k$ defines the slope of the rod where D is the rod diameter, then

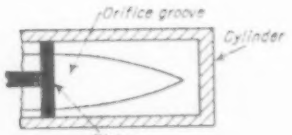


$$W \log_e \frac{v}{v_o} = \frac{c^2 \gamma}{8{,}800 k} \left[\frac{D^3 + 5a_c^2 D^3 - \left(\frac{15}{2}\right) d_c^4 D}{3(d_c^2 - D^2)} + \frac{5 d_c^3}{4} \log_e \left(\frac{d_c + D}{d_c - D} \right) \right]_{D_o}^{D} \quad (9)$$

Orifice formed by taperd slot in piston. The orifice area in this case and in the following one varies with stroke so that $a = a_o - ks$ for which

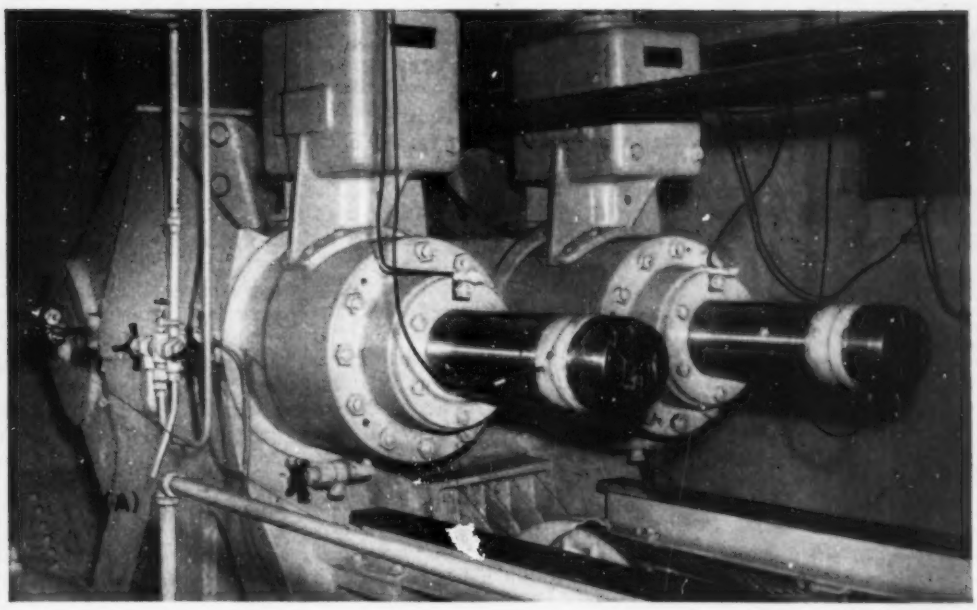
$$\log_e \frac{v_o}{v} = \frac{C^2 \gamma}{2kW} \left[A^3 \left(\frac{1}{a_o} - \frac{1}{a} \right) - 3A^3 \log_e \frac{a}{a_o} + 3A\,(a - a_o) - \frac{a^2 - a_o^2}{2} \right] \quad (10)$$

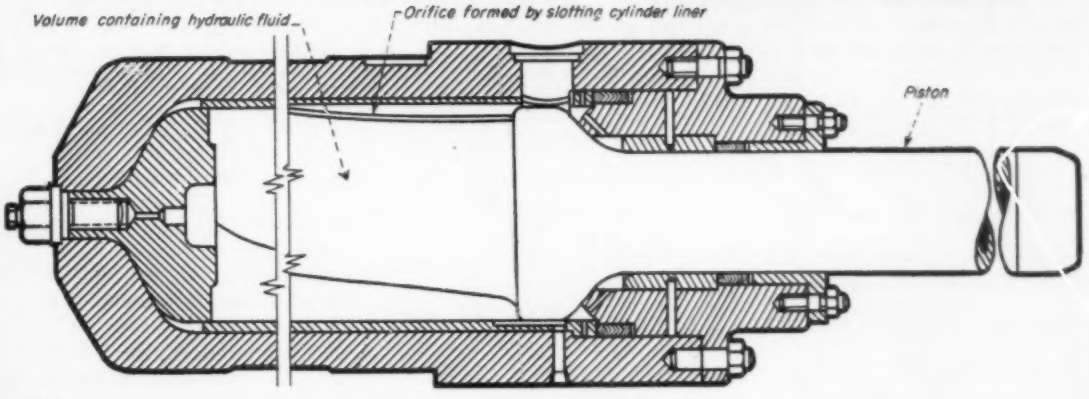
Orifice formed by helical sided groove in cylinder wall. Here, also, $a = a_o - ks$. Therefore



$$\log_e \frac{v_o}{v} = \frac{\gamma C^2 A^2}{2kW} \left(\frac{1}{a} - \frac{1}{a_o} \right) \quad (11)$$

Effect of Varying Weight and Speed on Constant Deceleration Brake. A buffer designed to produce constant deceleration or a constant retarding





(B)

Fig. 1—(A) Two hydraulic buffers mounted side by side on a Navy airplane catapult. Note the strain gages attached to the buffer pistons for determining impact effects. The mass that strikes these buffers consists of airplane and launching car. Their combined weight is approximately 8,000 lb moving at 70 mph at the instant of impact. (B) Cross-section drawing of one of the H4 catapult buffers. On impact, the hydraulic fluid is forced past the piston through an orifice machined into the cylinder walls.

force for a certain set of conditions sometimes is used in an entirely different application. For example, it may be desirable to mount a particular gun barrel in a carriage that was designed for a gun barrel of a different weight. Or it may be necessary to test the performance of a mechanism and the only decelerating means available is the hydraulic buffer designed for another type of mechanism. Ordinarily if the buffer is designed primarily with ease of manufacture in mind, the orifice dimensions will vary in some linear way as described above. It is possible by utilizing the equations given for approximately constant deceleration buffers to determine velocity and pressure characteristics for the new set of conditions. However, when the buffer is designed as a constant deceleration buffer for a given weight to be stopped at a given initial velocity, it will produce constant deceleration for these conditions only. The following analysis can be used in determining pressure and velocity characteristics when weight and velocity of moving body have been altered.

Let subscript 1 denote the characteristics of the body for which the buffer was designed. Let subscript 2 denote conditions for the new body and let subscript 0 denote initial conditions in either case. The orifice variation for constant deceleration is

$$a^2 = \frac{C^2\gamma_1 A^2 v_1^2}{2 W_1 f_1} \tag{12}$$

the force on the new body is

$$F_2 = \frac{W_2 f_2}{g} = \frac{\gamma C^2 A^2 v_2^2}{2ga^2} = \frac{\gamma C^2 A^2 v_2^2}{2g\left(\frac{C^2\gamma_1 A^2 v_1^2}{2W_1 f_1}\right)} = \frac{W_1 f_1}{g}\left(\frac{v_2}{v_1}\right)^2 \tag{13}$$

But $f_2 = \frac{v_2\,dv_2}{ds}$ and is variable whereas f_1 is constant.

Thus $W_1 f_1 \left(\frac{v_2}{v_1}\right)^2 = W_2 v_2 \frac{dv_2}{ds}$

Since f_1 is constant

$$v_1^2 = v_{10}^2 + 2f_1 s$$

$$\frac{W_1 f_1 v_2^2}{W_2 (v_{10}^2 + 2f_1 s)} = v_2 \frac{dv_2}{ds} \text{ or}$$

$$\frac{W_1 f_1 ds}{W_2 (v_{10}^2 + 2f_1 s)} = \frac{dv_2}{v_2}$$

Integrating

$$\frac{W_1}{2W_2} \log_e \frac{v_{10}^2 + 2f_1 s}{v_{10}^2} = \log_e \frac{v_2}{v_{20}}$$

and $\left[\frac{v_{10}^2 + 2f_1 s}{v_{10}^2}\right]^{\frac{W_1}{2W_2}} = \left(\frac{v_1}{v_{10}}\right)^{\frac{W_1}{W_2}} = \frac{v_2}{v_{20}}$

Thus, the velocity of the new body as compared to the velocity of the original body for a given point along the stroke is

$$v_2 = v_{20} \left(\frac{v_1}{v_{10}}\right)^{\frac{W_1}{W_2}} \qquad (14)$$

A special case exists when $W_1 = W_2$. Then, v_2 will be proportional to v_1. By substituting Eq (14) in Eq (13), it can be seen that f_2 is also a constant and that the stroke will remain the same as in condition (1), since

$$f_2 = f_1 \left(\frac{v_{20}}{v_{10}}\right)^2 = \frac{v_{10}^2}{2s_1}\left(\frac{v_{20}}{v_{10}}\right)^2 = \frac{v_{20}^2}{2s_1}$$

Going back to the case where W_1 is not equal to W_2, $p_2 = \frac{\gamma C^2 A^2 v_2^2}{2gA^2}$ is the pressure at a given point. But at the same point for the original condition (1) $p_1 = \frac{\gamma C^2 A^2 v_1^2}{2gA^2}$ and is a constant of known value.
Thus

$$p_2 = p_1 \left(\frac{v_2}{v_1}\right)^2 = p_1 \left[\frac{v_{20}}{v_1}\right]^2 \left(\frac{v_1}{v_{10}}\right)^{\frac{2W_1}{W_2}}$$

$$= \frac{p_1 v_{20}^2}{v_{10}^{2W_1/W_2}} \left[v_1^{2\left(\frac{W_1}{W_2} - 1\right)}\right]$$

And since $v_1^2 = v_{10}^2 + 2f_1 s$

$$p_2 = p_1 \frac{v_{20}^2}{v_{10}^{2W_1/W_2}} (v_{10}^2 + 2f_1 s)^{\left(\frac{W_1}{W_2} - 1\right)}$$

This gives the pressure at any point for the modified condition.

Analyzing this last equation, it is seen that for the case where W_1 is less than W_2, or where the weight is increased above design conditions, the factor $W_1/W_2 - 1$ is less than zero. Then at the end of travel, when $v_{10}^2 + 2f_1 s = 0$, p_2 will become infinite since the zero will be in the denominator. This, then, indicates that in this case the kinetic energy of the body must be so limited that it is practically all consumed prior to the completition of the stroke, so that an allowable bottoming velocity will not be exceeded.

When W_1 exceeds W_2, the final pressure (p_2) equals zero. This indicates a shortened buffer stroke. When W_1 *equals* W_2, this equation is indeterminate. But it has been shown that the stroke will be the same as for condition (1) and that the pressure will vary as the square of the initial velocity.

To compute the energy absorbed up to any distance s along the stroke:

$$\text{Energy} = \int p_2 A ds = \int \frac{p_1 v_{20}^2}{v_{10}^{2W_1/W_2}} \times (v_{10}^2 + 2f_1 s)^{\left(\frac{W_1}{W_2} - 1\right)} A ds$$

$$= \frac{A}{2f_1}\frac{W_2}{W_1} p_1 v_{20}^2 \times \left[\left(1 + \frac{2f_1 s}{v_{10}^2}\right)^{\frac{W_1}{W_2}} - 1\right]$$

$$= \frac{W_2 v_{20}^2}{2g} \times \left[\left(1 + \frac{2f_1 s}{v_{10}^2}\right)^{\frac{W_1}{W_2}} - 1\right]$$

Since $Ap_1 = \frac{W_1 f_1}{g}$

In the case where W_1 is less than W_2, a balance must be sought between the energy left unabsorbed by the buffer orifice and the energy stored in the buffer fluid. Thus

$$\frac{W_2 v_{20}^2}{2g}\left(1 + \frac{2f_1 s}{v_{10}}\right)\frac{W_1}{W_2} = \frac{Ap\delta^2}{2} = \frac{ApV}{2B}$$

where δ is the linear compression in the fluid and B is the bulk modulus of the brake liquid. P_{max} may be solved for in the above equation.

Compound Buffer Action

Two hydraulic buffers are sometimes placed in series to alleviate impact conditions. In analyzing a typical case, it is seen that the forces applied to both buffer pistons are equal at any instant. Since the forces are directly dependent upon the velocities, the ratio of velocities for the two buffers can be determined for any position along the stroke. For example, consider a buffer of constant area (subscript 1) striking a buffer designed for constant deceleration (subscript 2). Then, neglecting buffer weight:

$p_1 A_1 = \frac{C^2 \gamma A_1^3 v_1^2}{2a_1^2 g} = \frac{C^2 \gamma A_2^3 v_2^2}{2a_2^2 g}$ where γ and C are assumed to be the same for both buffers and v is the velocity of the piston relative to the buffer cylinder.

$\left(\frac{v_1}{v_2}\right)^2 = \left(\frac{A_2}{A_1}\right)^2 \left(\frac{a_1}{a_2}\right)^2$. For the buffers in question $\frac{A_2}{A_1}$ is a constant.

Therefore let $\left(\frac{A_2}{A_1}\right)^{3/2} = k$ so that $v_1 = k \frac{a_1}{a_2} v_2$. Now A_1 and a_2 are constant. Thus, $v_1 = k_2 v_2$ where $k_2 = k a_1/a_2$.

$ds_1/dt = k_2\, ds_2/dt$.

Let s_o be the distance advanced during the buffer stroke by the body to be stopped. Then $s_o = s_1 + s_2$. Also,

$$v_o = v_1 + v_2 = v_2(1 + k_2) = v_1\left(\frac{1 + k_2}{k_2}\right)$$

$$\frac{W}{2g}(v_{oo}^2 - v_o^2) = \int_0^{s_1} \frac{C^2 \gamma A_1^3 v_1^2 ds_1}{2a_1^2 g} + \int_0^{s_2} \frac{C^2 \gamma A_2^3 v_2^2 ds_2}{2a_2^2 g}$$

$$-\int \frac{W}{g} v_o dv_o = \frac{C^2 \gamma}{2g}\left[\int_0^{s_1} \frac{A_1^3 v_1^2 ds_1}{a_1^2} + \int_0^{s_2} \frac{A_2^3 v_2^2 ds_2}{a_2^2}\right]$$

$$= \frac{C_2 \gamma}{2}\left[\int_0^{S_1} \frac{A_1^3 \left(\frac{K}{1 + K_2}\right)^2 v_o^2 ds_1}{a_1^2} + \int_0^{S^2} \frac{A_2^3 v_o^2}{(1 + K_2)^2}\frac{ds_2}{a_2^2}\right]$$

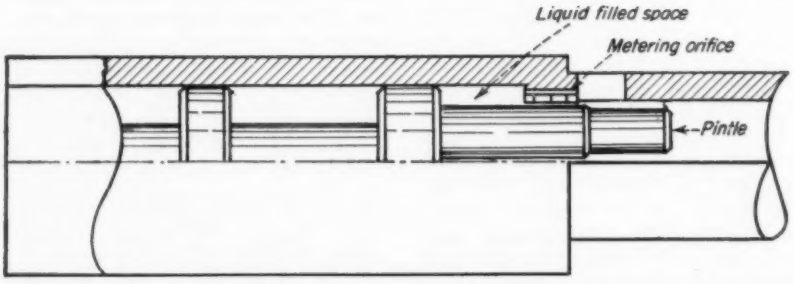


Fig. 2—Principles of buffer design were applied to design of an automatically operated valve. Hydraulic fluid retards the movement of the valve pintle against valve body.

$$-\int_{v_{oo}}^{v_o}\frac{dv_o}{v_o}=\frac{\gamma}{2W}\left(\frac{C}{1+k_2}\right)^2 \times\left[\int_0^{s_1}K_2^2\frac{A_1^3}{a_1^2}ds_1+\int_0^{s_1/K_2}\frac{A_2^3}{a_2^2}\frac{ds_1}{k_2}\right]$$

$$\log_e\frac{v_{oo}}{v_o}=\frac{\gamma}{2W}\left(\frac{C}{1+k_2}\right)^2 S_1 \times\left[\frac{A_1^3}{a_1^2}k_2^2+\frac{A_2^3}{a_2^2k_2^2}\right]$$

Thus for any value of s_1, the magnitude of v_o is determined. For any value of v_o, values for v_1, v_2, p_1 and p_2 may be calculated from the above relationships. Other combinations of hydraulic buffers can be computed in similar manner.

Compression Type Buffers

Simple Pneumatic

Let p = gas pressure, absolute
V = volume
k = specific heat ratio
Subscript 1 = initial conditions
Subscript 2 = final conditions

The energy of the weight to be halted can be represented by $Wv^2/2g$. Also, the energy needed to compress the gas is $(p_2V_2 - p_1V_1)/k\text{-}1$.

$$\text{Thus } \frac{W}{2g}v^2=144\left[\frac{p_2V_2-p_1V_1}{k-1}\right] \quad (15)$$

$$\text{Also } p_2=p_1\left(\frac{V_1}{V_2}\right)^k$$

$$\text{or } \frac{W}{2g}v^2=\frac{144\,p_1V_1}{k-1}\left[\left(\frac{V_1}{V_2}\right)^{(k-1)^{-1}}\right] \quad (16)$$

The above formulas are theoretical only, based upon 100 percent efficiency of brake operation. Actually air leakage decreases the maximum pressure of p_2 and increases the stroke. There is a limit to permissible leakage, since excessive leakage may result in disasterous bottoming of the piston. Friction forces will also decrease p_2. Thus, the theoretical value of p_2 is conservative and it can be used as the basis for the buffer design.

In cases of extremely high compression, the ideal gas law must be modified. It becomes $pv = cnRT$, where c is a compressibility factor. For pressures of 100 atmospheres, this factor is 1.05. At a pressure of 200 atmospheres, the factor is 1.10. The compressibility factor is not usually considered in buffer design because its magnitude is not excessive. Any errors arriving from neglect of the compressibility factor are minimized since Eqs (15) and (16) are on the conservative side as discussed above.

The design of non-simple pneumatic buffers, such as those with auxiliary air supply, is somewhat more tedious. The performance of these brakes can be analyzed by simple thermodynamic relationships. But the motion must be divided in small intervals and solved approximately, due mainly to the exponential characteristics of the available relationships.

Hydraulic Buffers. The hydraulic buffers previously covered were of the orifice type in which energy is dissipated. A second kind of hydraulic buffer is the energy storing type. Braking force is proportional to displacement since the bulk modulus of the fluid is practically constant. The energy equation is set up from the following relationships. Let

B = bulk modulus (average)
V = liquid volume
p = liquid pressure
A_1 = effective piston area during braking stroke

$$\text{By definition, } B=p\frac{V}{\Delta V}$$

$$F=A_1p=A_1B\frac{\Delta V}{V}$$

$$K.E.=1/2\,F_{max}\,s=1/2\,A_1B\frac{\Delta V}{V}s$$

And since $\Delta V = A_1 s$,

$$K.E.=1/2\,A_1^2\frac{B\,s^2}{V}$$

This energy is stored almost entirely in the liquid and must be dissipated if rebound of equal velocity is to be avoided. In the Dowty brake this is accomplished by the presence of constant area orifices in the piston head. The magnitude of the total area of these orifices is determined as follows:

Let A_2 = effective piston area on return stroke
W_p = piston weight

Then, the force equation for the piston can be written as

$$\frac{A_1^2Bs}{V}=\frac{W_pf}{g}+\frac{C^2\gamma A_2^3v^2}{2a^2g}$$

$$=\frac{W_p}{g}\frac{vdv}{ds}+\frac{C^2\gamma A_2^3v^2}{2a^2g}$$

This is a linear differential equation of first order, solution of which is

$$v^2=\frac{A_1^2BW_p}{2VK^2g}\left(\frac{2Ksg}{W_p}-1\right)+\frac{A_1^2BW_p}{2V_oK^2}e^{-\frac{2Ksg}{W_p}}$$

where $K=\frac{C^2\gamma A_2^3}{2a^2g}$

The proper orifice area is found from the above equation by cut-and-try. By substituting various values of orifice areas (a), the designer can determine orifice area needed to produce the allowable velocity (v) at the desired piston stroke (s).

Conclusions

The principles here presented are applicable not only to buffer design but also to related fields in hydraulics. For instance, by use of the given relationships, it is possible to decelerate the pintle of an automatic valve so as to avoid noisy or damaging impact upon the seat. The sketch in Fig. 2 shows the construction of a valve employing a built-in buffer. In general, anyone confronted with hydraulic metering problems, controlled variable accelerations or energy dissipation devices may find this analyses valuable.

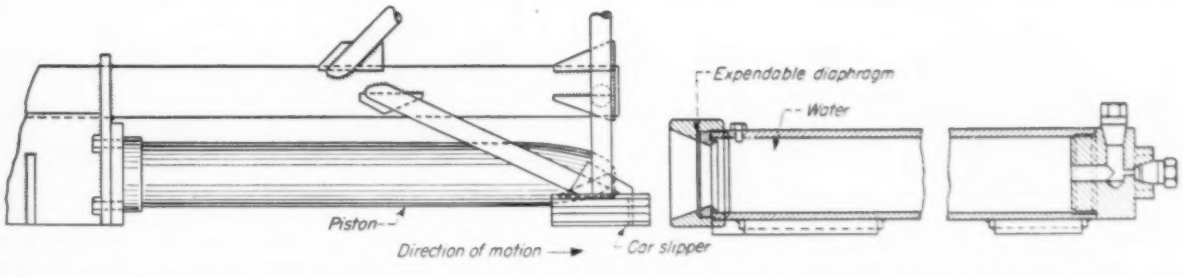


Fig. 3—Water brake is form of hydraulic buffer. It is an economical means of stopping heavy, fast moving loads. Diaphragm and water must be replaced after each usage. Water brakes are definitely not suited for operations that are rapidly repeated.

Types of Mounts fo Vi

TRANSMISSION OF VIBRATION from a machine or motor to the supporting structure can be reduced by using special mountings. Vibrations may be caused by an unbalanced rotor or reciprocating elements of a machine. By flexibly supporting the vibrating member, the disturbance can be greatly absorbed by the resilient mounting.

For most effective vibration isolation, the mounting should be very soft so that its natural frequency is low in comparison to the frequency of the disturbance. As a rule, the disturbing frequency should always be greater than 2.5 times the natural frequency of the mounted system. For *simple linear vibrations*, the natural frequency of the supported mass f_n can be determined by the static deflection of the springs or mount. This is expressed by:

$$f_n = 188 \div \sqrt{d} \text{ (in cpm)}$$

This equation is graphically illustrated on page 167; in addition, a chart is given to determine the isolation efficiency of a particular mount.

There are many commercial mounts available. Most of these devices utilize rubber for resiliency; this rubber is most often stressed in shear to obtain larger static deflection for a gi thickness. Where greater load capacity (per unit volume) required, rubber in compression is used.

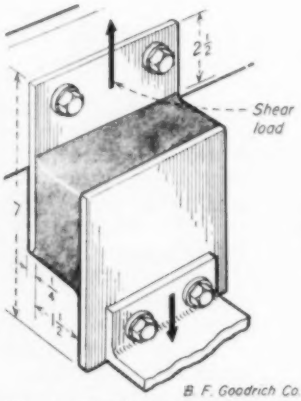
An unrestrained body mounted on four resilient mounts, h six modes of vibration and consequently six natural frequenci The analysis of such vibrations is described in PRODUCT EN NEERING, November 1945.

For single-degree translational motion of a body which is su ported on more than one mount, the stiffness of each unit shou be in proportion to the weight supported. Besides motion in t vertical plane, the natural frequency in the horizontal plane sho be also calculated. For the lowest natural frequency of the syste mountings should be loaded close to the maximum rating given

In applying vibration mounts, three factors are important: (1 keep mounts far apart for better stability; (2) mounts should b in a plane which passes through the center of gravity of the su pended mass; (3) use of hold-down screws or snubbers to lim large motions.

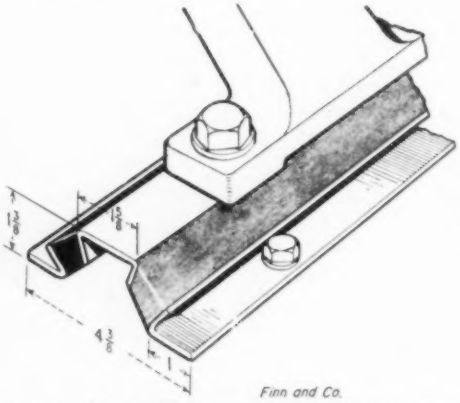
A detailed discussion of the application of vibration mounts given in PRODUCT ENGINEERING, September and October 1948

STRIP-TYPE ISOLATORS



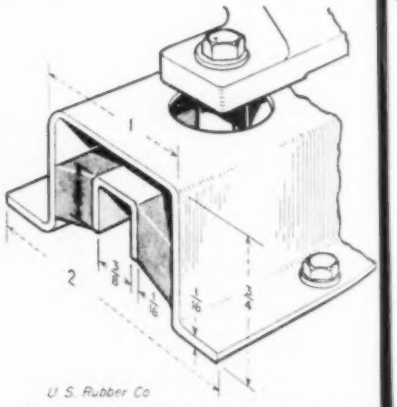
B. F. Goodrich Co.

Fig. 1—Rated at 80 lb/linear in. with a shear deflection of 1 in., this type has a compression rating of 250 lb/linear in. at 5/16 in. deflection. Requires drilling and cutting to proper length.



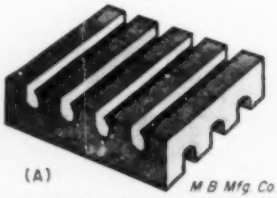
Finn and Co.

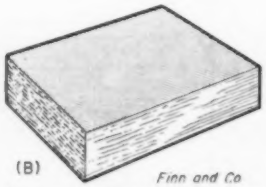
Fig. 2—This mount has ratings from 40 to 105 lb/linear in. and deflects ¼ in. Rubber is stressed in shear and compression. As a result, the load deflection curve is non-linear, which prevents resonance.

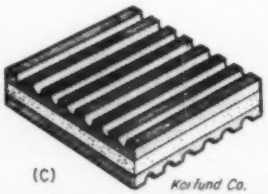


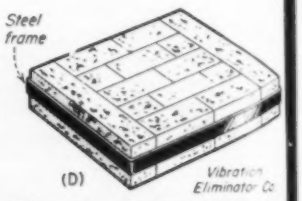
U. S. Rubber Co

Fig. 3—Channel-type mounting comes in two basic sizes: small, for vertical loads up to 95 lb (illustrated); large, for loads to 420 lb. Lengths are 1 to 7 in. Can be inverted for overhead suspensions.


(A) M B Mfg. Co


(B) Finn and Co


(C) Korfund Co.



(D) Vibration Eliminator Co

Fig. 4—For heavy, flat base, equipment several materials are available for vibration isolation; these are most effective where very high frequencies and disturbing sound are to be reduced. Sheets of felt, cork, and rubber are most commonly used. (A) *Isomode* pads of neoprene are 5/16 in. thick and are used at loadings of from 10 to 60 psi. Maximum deflected height is ¼ in.; several layers can be used. (B) *Vibrapad* consisting of alternate layers of cotton duck and rubber, ⅜ in. thick, is used for loads up to 200 psi. (C) *Elasto-rib* is a combination of cork and ribbed-rubber which is rated up to 35 psi. Minimum thickness is 1 in. (D) Natural cork plates are held by a steel frame. Thickness ranges from 1 to 4 in. and widths up to 24 inches

Vibration Isolation

THOMAS R. FINN
Finn and Company

INDIVIDUAL MOUNTS

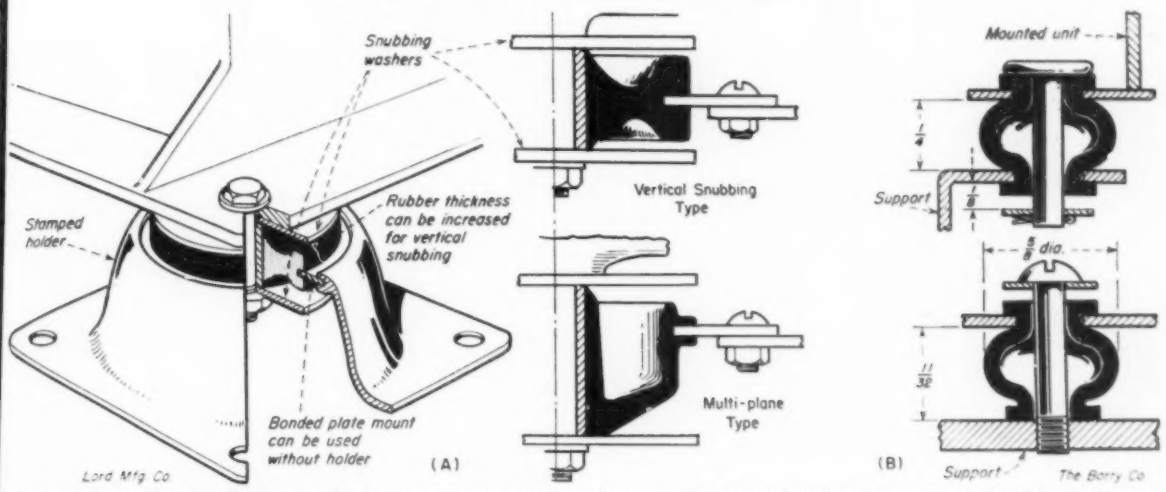


Fig. 5—(A) Axial ratings of this standard series are: 1 to 90 lb at deflections of 1/16 or ¼ in. Mounting is about twice as stiff radially as compared to the axial direction. For loads up to 310 lb, the rubber is solid. (B) Small mount is rated from 1/3 to 3 lb per unit. Isolates vibrations as low as 900 cpm in all directions. Attachment is simplified by punched or tapped holes.

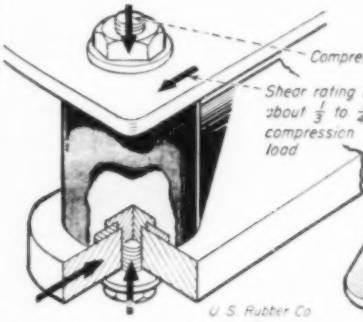


Fig. 6—Stud-type pads are simple to attach and rated in compression from 2 to 270 lb, but limited to applications of shear and compression forces. Pads with tapped holes are made for cap screws.

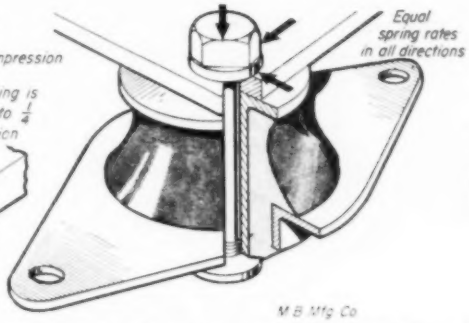


Fig. 7—Mounts are rated at 150 to 2,670 lb at 0.15 in. deflection. The natural frequency is about 490 cpm. Sleeve ID varies from 0.437 to 1.00 in. and the overall height is from 1.75 to 4.00 in.

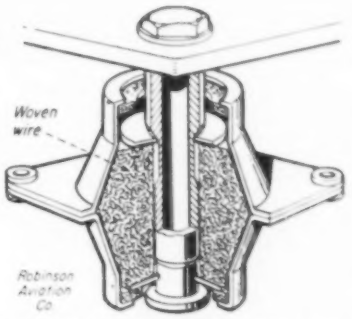


Fig. 8—All metal mount for extreme temperature conditions. Woven wire is used for resilient element. With a varying spring rate, it has good damping effects. Unit load ratings are from 2 to 25 lb.

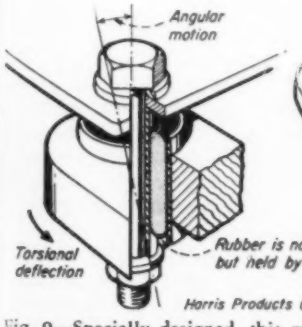


Fig. 9—Specially designed, this mount is widely used in automotive industry. Besides axial and radial resiliency, it is used for torsional and angular motion.

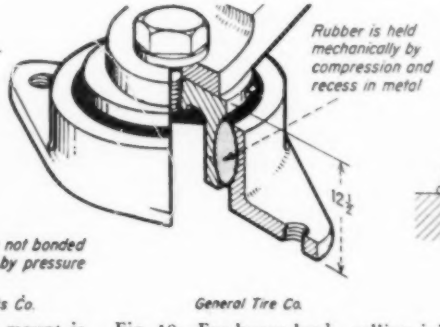


Fig. 10—For heavy loads, rolling joint is useful in applications where alignment is important. Normal ratings range from 125 to 1,500 lb at 0.24 in. deflection.

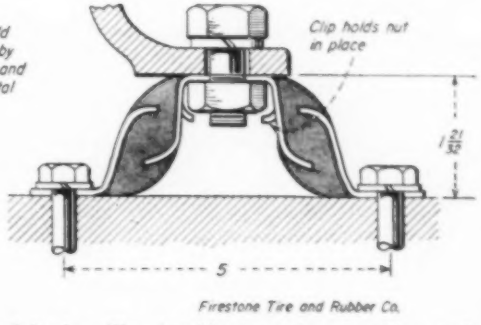
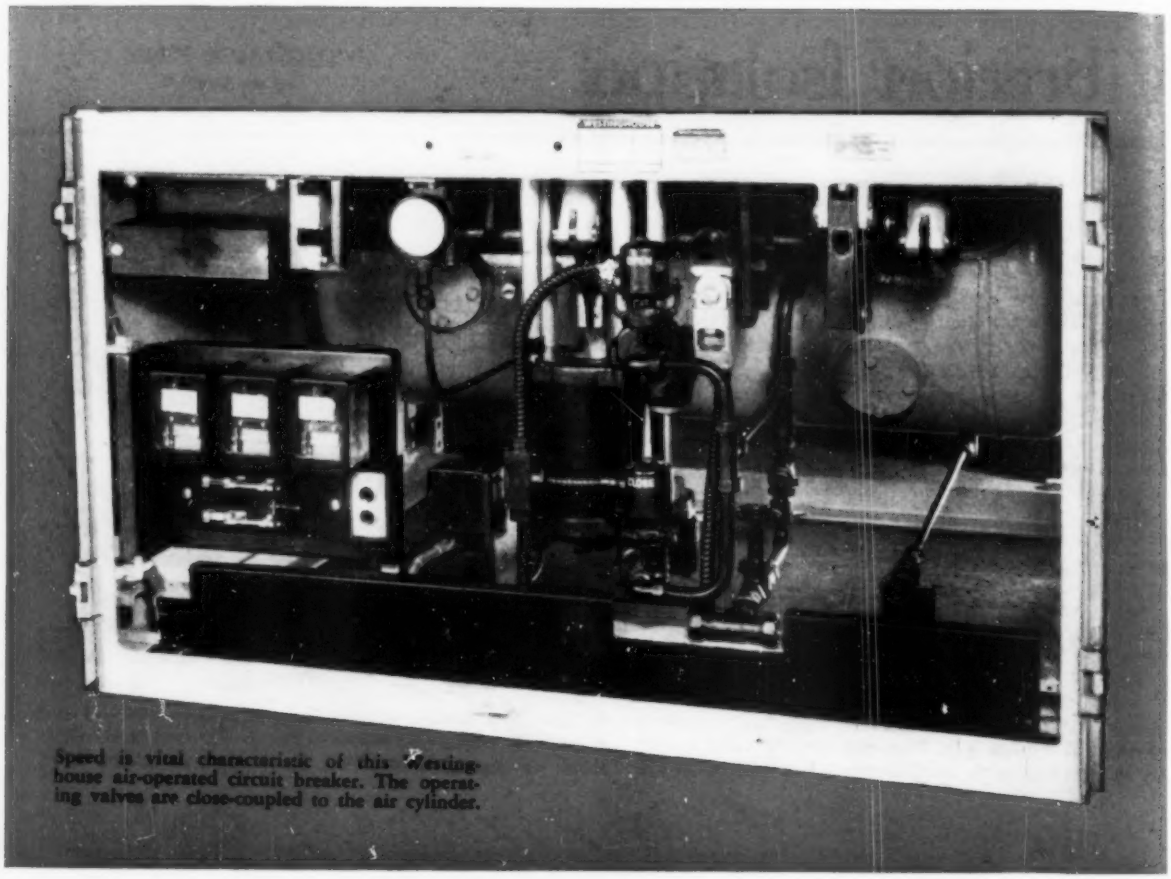


Fig. 11—Metal reinforced rubber pads are designed for loads of 250 to 1,700 lb. All pads have the same overall dimensions. Attaching bolts are: ½, ⅜ or ¼ inch.



Speed is vital characteristic of this Westinghouse air-operated circuit breaker. The operating valves are close-coupled to the air cylinder.

R. J. CAMERON
Ross Operating Valve Company

High Speed Pneumatic Circuits

Fast action is a characteristic of most pneumatic devices. But close-coupling and pilot operation make them faster still

THE DESIGNER OF AN AIR-OPERATED MACHINE has little choice in the loca- of the actuating cylinder. Since the cylinder must be mechanically connected to the working part, it is mounted as near to that part as possible. The placement of the operating valves, however, is another story. There is no such obvious limitation that governs valve location. As a result, the designer is often guided by convenience—rather than sound engineering principles—when installing a valve in a machine.

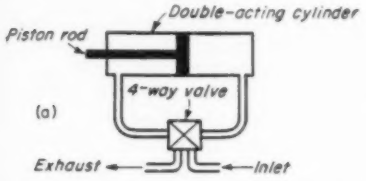
From an efficiency standpoint, placement of the operating valve should not be treated casually. There is an optimum location for the valve. For best results, an operating valve should be close-coupled to the actuating cylinder.

One advantage to be gained from close-coupling is fast operation, since the operating air has less distance to travel. Admission and exhaust of air follows valve action immediately. There is no delay between valve and cylinder actions as occurs when sizeable lengths of pipe must be filled with or emptied of air. Thus, close-coupling appreciably lessens the time-lag between the instant a control action is initiated and the beginning of piston movement.

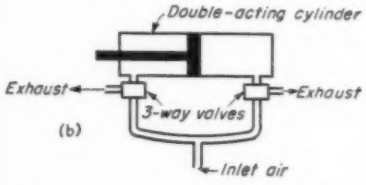
Close-coupling has the further advantage of actually using less air than would be required otherwise. If long lengths of pipe are connected between valve and cylinder, air waste is unavoidable. For each operation, the inlet pipes as well as the cylinder must be filled with air. The air in the

pipes is non-productive and is a total loss. Over long periods of time, the actual saving in air cost may prove to be considerable. In addition, the extra length of pipe increases pressure drop, which can affect both the cost and the speed of operation. Occasionally, close-coupling allows the use of a smaller size valve than was previously employed in a particular air circuit. Since air waste is less and piston movement faster with close-coupling, valve diameter can be reduced and yet pass sufficient air to maintain the normal operating speed of the machine.

In some cases, close-coupling can be accomplished with a single 4-way valve. The valve is located as depicted in sketch (a), as close to the cylinder body as practical. Generally, this arrangement is advised only for short stroke cylinders.



In the majority of applications, it is usually more practical to use two 3-way valves for close-coupling in lieu of the single 4-way valve. A 4-way valve is actually a combination of a normally-open and a normally-closed 3-way valve. Each of the two valves is mounted as shown in sketch (b), directly on either end of the cylinder. A short nipple ordinarily serves as the connecting means. The use of two valves is definitely recommended where long cylinders are employed.



In some cases, the operating valves can be designed as integral elements of the cylinder heads. This arrangement provides the fastest piston response and a minimum of air waste and pressure drop. However, such a valve assembly must be designed individually for each specific cylinder application. Thus, integral valve assemblies are impractical costwise except where quantity production is anticipated. The vacuum-powered window lift apparatus available on Kaiser-Frazer automobiles incorporates integral valve-cylinder assemblies. Here, of course, the manufacturing volume involved quickly compensates for the cost of engineering and special tooling.

The use of two 3-way valves on a double acting cylinder makes it possible to supply different air pressures for the power and return strokes. The power stroke will often require a specific pressure, either high or low, because in its action it creates a pressure or squeeze on the work. Because the air travels through an independent 3-way valve, the pressure may be easily varied ahead of this valve without affecting the return stroke. Likewise, the return stroke, being independent, may use only so much pressure as would be required to furnish the necessary speed of withdrawal for the application. In some cases the use of reduced air pressure for either stroke will result in considerable savings of compressed air.

Actuation of Operating Valves

Close-coupled valves may be actuated directly (manually or by means of cams, trip dogs or solenoids) or indirectly through a pilot valve. The pilot valve in turn may be controlled manually, mechanically or electrically.

As far as valve actuation is concerned, the first problem for the designer is to choose between manual, mechanical and electrical means. The main determining factor is the nature of the application and the degree of automation wanted. Where the air cylinder is not conveniently accessible, where complicated lever systems are undesirable, or where pushbutton or Microswitch tripping is essential, the usual choice is solenoid actuation.

The advantages of the solenoid valve are apparent. Operation is rapid. Response to control action is instantaneous. Arrangement of the control device with relation to the cylinder and valve is very flexible. The control device may be a push-button on a remote panel, or it may be a limit switch located at the far end of the machine from the valve. Interlocking and fail-safe provisions are simply accomplished. Operator carelessness or rough handling cannot affect the life of the valve.

Operating valves are now at a stage of development where many millions of operations may be expected before repair is needed. Valves of rugged construction last many many millions of operations without any maintenance down-time whatever, except in the control portion of the circuit.

Life-expectancy of a solenoid is not as great as that of the operating valve. Sometimes a solenoid must be repaired or replaced before the valve requires attention. The breakdown of a solenoid is due to impact rather than wear. Normally, a solenoid armature consists of a stack of silicon iron laminations riveted together. Continuing impact, stresses, and fatigue can lead to failure.

To reduce the problem of solenoid life, many designers are adopting pilot operated valves. Pilot air pressure is used to shift the main valve, while the pilot valve itself may be solenoid actuated. In such cases the solenoid is small in size and thus will last much longer than the large solenoid that would be needed to shift the main valve directly.

Certainly an important point about small solenoids is the fact that small solenoids require considerably less current. This factor is very important when a group of solenoid valves are used on an installation, since current consumption on several solenoid valves can add up to a considerable requirement.

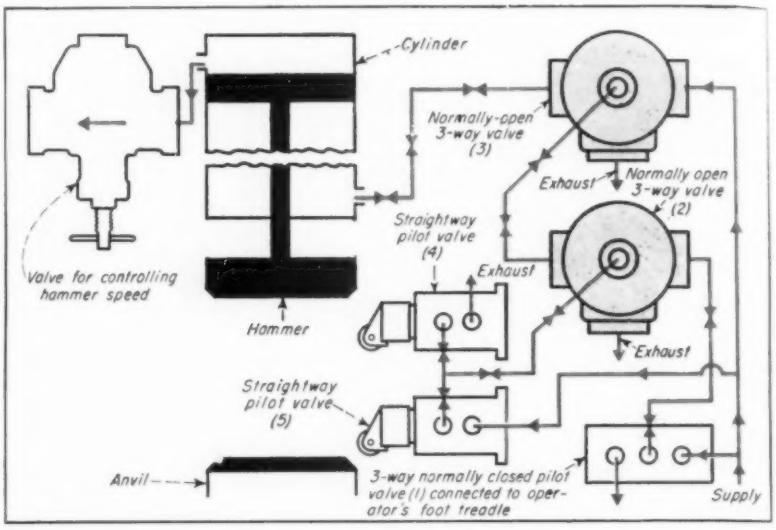
Pilot operated solenoid valves are ordinarily lower in cost than direct solenoid operated valves. This is because the solenoids themselves are expensive—accounting for as much as $\frac{2}{3}$ of the cost of a large size solenoid valve. In solenoid actuated, pilot operated valves the solenoids are small in size and may represent only 1/5 of the total valve cost. With pilot operation, solenoid cost does not go up in proportion to the size and complexity of the main valve. The same solenoid can be used for a great variety of valve sizes. Thus, standardization also contributes to the economy of pilot operation.

Pilot operated master valves have the same flexibility of location and control that characterize the solenoid valve. The current trend on machines using many operating cylinders is to mount the control solenoid and pilot valve (or pilot valves having other means of actuation) in the control panel, where they are accessible for maintenance. Electrical apparatus and wiring can be isolated in an enclosure having any desired protection.

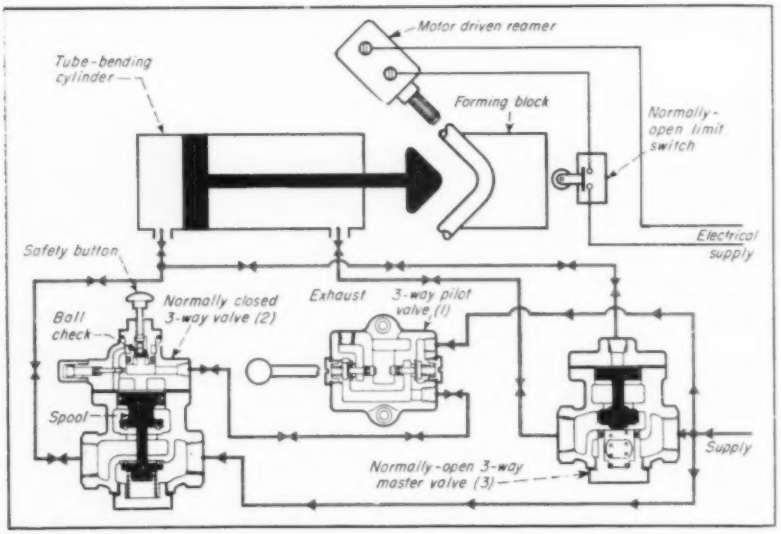
The major delay between the tripping of a control switch and valve operation is the time needed for armature movement. Armature travel in a direct operated solenoid valve may be as great as 1-$\frac{1}{2}$ in., compared to only $\frac{1}{8}$ in. travel in a pilot valve. Thus, it is seen that pilot operated valves by their very design act more quickly than direct operated solenoid valves. Machine designers who require fast acting pneumatic circuits should consider combination of close-coupling with solenoid actuated, pilot-operated valves. *(continued on next page)*

High-Speed Pneumatic Circuits (continued)

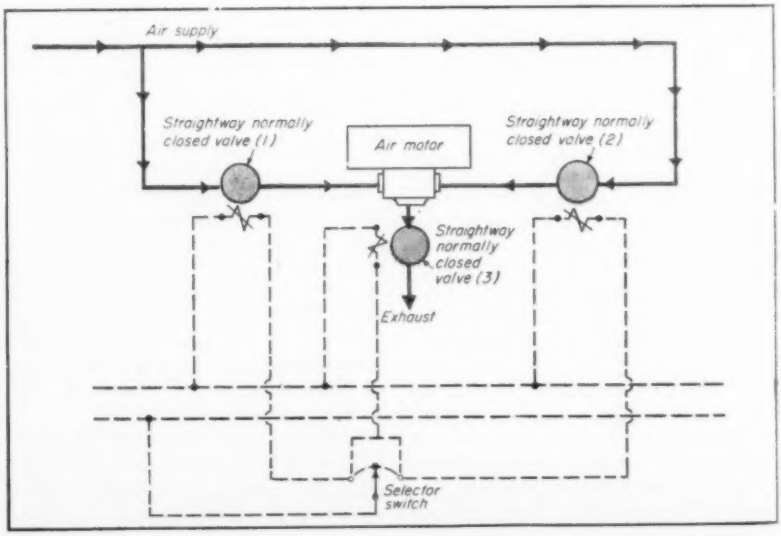
1 Drop forging hammer is controlled by pilot operated close-coupled valves. When the foot treadle is depressed, the pilot valve supplies air through valve 2 to the head of valve 3. Operation of valve 3 allows the hammer to drop by cutting off air and opening the bottom of the cylinder to exhaust. The hammer strikes valve 4, which does not affect the circuit at this time. Continuing downward, the hammer hits pilot valve 5, which supplies air to the head of valve 2. The shifting of valve 2 opens the head of valve 3 to exhaust. Valve 3 reverses and causes the hammer to be lifted. In its upward travel, the hammer hits valve 5 again (with no effect this time) and then strikes valve 4. This exhausts the air in the head of valve 2, reversing this valve which in turn shifts valve 3 again. Then, the hammer will drop again.

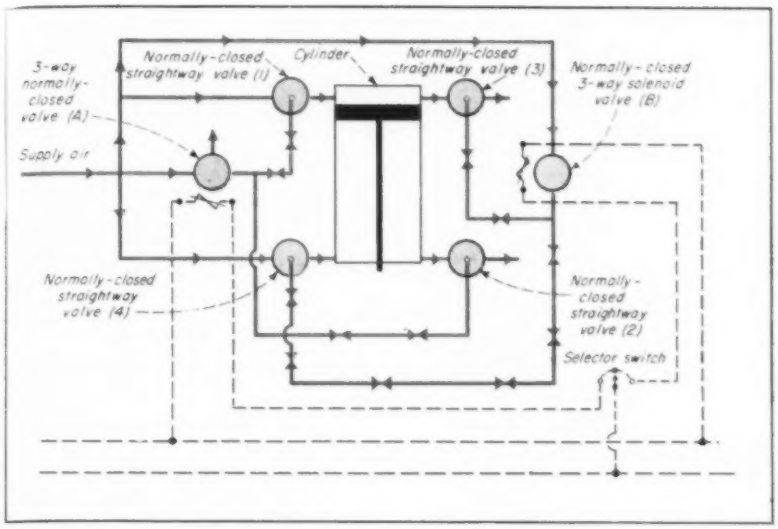


2 Tube forming machine bends the tube, reams the tube end, withdraws the ream and then releases the tube. Momentary operation of the valve 1 supplies air to the head of valve 2. Air flows past the ball check above the head of the operating spool, immediately reversing this valve. This action supplies air to the cylinder, advancing the piston against the tube. Note that the air supplied to the cylinder is also teed off to the head of valve 3 so that valve 3 is reversed by the action of valve 2, permitting piston to advance. The piston bends the tube against the block until it trips the limit switch 4, which starts operation of the motor driven reamer. The reamer reams the tube and withdraws. After a time delay, determined by the setting of the needle in its head, valve 2 reverses, shifting valve 3 and withdrawing the bending rod.

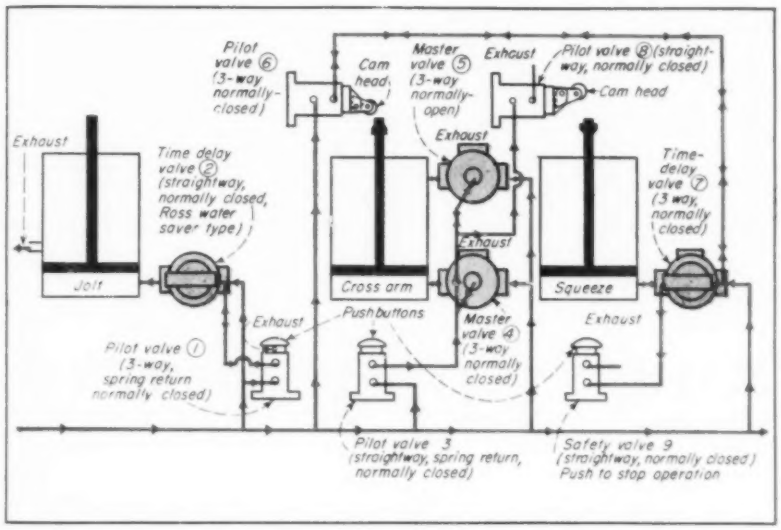


3 A circuit for alternate clockwise or counter-clockwise rotation of an air motor with positive stop. In this circuit, if the selector switch is returned to the right, the straightway normally-closed valve 2 is energized, supplying air to the air motor. At the same time, the normally-closed valve 3 is energized allowing the air supplied by valve 2 to exhaust through the motor. If the selector switch is thrown to the left, then normally-closed valves 1 and 3 are energized, supplying air to the motor and opening exhaust of the motor. If the selector switch is returned to the neutral position, all three normally-closed valves are closed and the air motor will be motionless. Note that in this case the operating valves are actuated by means of solenoids. The control switch may be located remotely from the valves. All valves are close-coupled to the air motor to assure fast response to control.

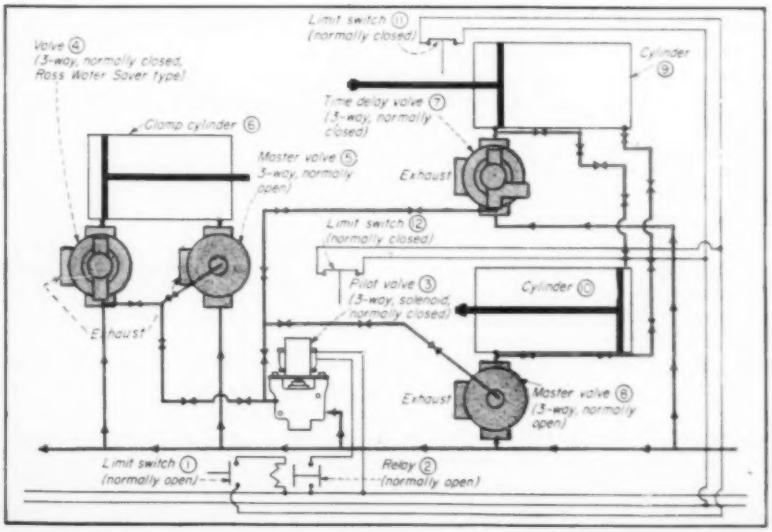




4 Circuit using pilot operated, close-coupled valves to duplicate the action of a 3-position, 4-way double solenoid valve. In the neutral position, the operating piston is locked by air trapped in the cylinder. When selector switch is thrown to the right, valve B is reversed, providing air to the heads of master valves 3 and 4. This supplies air to the lower end of the cylinder and exhausts air from the upper end, causing the piston rod to retract. The return of the selector switch to the neutral position de-engerizes the solenoid of valve B, exhausting the heads of valves 3 and 4 and closing them. This traps the air in the cylinder. Throwing the selector switch to the left energizes the solenoid of the valve A, which provides air to the heads of master valves 1 and 2 reversing them and extending the piston rod.



5 Jolt circuit of this foundry machine is started with the momentary operation of valve 1, which supplies air to the head of valve 2. This valve immediately opens, causing air to flow behind the jolt piston. The oscillation will continue for the number of cycles pre-set by the needle adjustment in the head of valve 2. The cross arm squeeze circuit is initiated by the depression of valve 3, which supplies air to the heads of valves 4 and 5. This reverses the cross arm cylinder, causing the piston to advance and trip valve 6. This momentarily supplies air to the head of valve 7, which reverses causing the squeeze cylinder rod to advance, overriding the cam of valve 8. After a time delay, valve 7 reverses, causing the squeeze rod to withdraw and tripping valve 8. This exhausts the heads of valves 4 and 5, retracting the cross arm rod.


Limit switch ① (normally closed)
Valve ④ (3-way, normally closed, Ross Water Saver type)
Cylinder ⑨
Time delay valve ⑦ (3-way, normally closed)
Clamp cylinder ⑥
Master valve ⑤ (3-way, normally open)
Exhaust
Limit switch ② (normally closed)
Pilot valve ③ (3-way, solenoid, normally closed)
Cylinder ⑩
Exhaust
Exhaust
Master valve ⑧ (3-way, normally open)
Limit switch ① (normally open)
Relay ② (normally open)

6 Circuit for operation of a tube bending fixture. Momentary closing of limit switch 1 actuates valve 3 through relay 2. This admits air to the heads of valves 4, 5, 7 and 8. Valves 4, 5 and 8 reverse immediately, causing the clamping rod to advance and exhausting air from the rod end of cylinder 10 and the blank end of cylinder 9. After a time lag, valve 7 also reverses, causing the rod of cylinder 9 to retract and the rod of cylinder 10 to advance. When piston of cylinder 9 retracts, it opens limit switch 11. When the rod of cylinder 10 advances, it opens limit switch 12. These act to de-energize relay 2 and pilot valve 3. (Limit switches 11 and 12 are interlocked.) This exhausts the pilot circuit, immediately reversing valves 5, 7 and 8, causing piston 9 to advance and piston 10 to retract. Valve 4 reverses after a time lag and causes the rod of the clamping cylinder to retract.

"Once-Through" Applications of Oils
(Boundary Lubrication)

METHOD	PARTS SERVED
Hand Oiling (Oil Can)	Plain Bearings, Gears, Sliding Surfaces
Drop-Feed Oiler	Plain and Anti-Friction Bearings
Wick-Feed Oiler	Plain and Anti-Friction Bearings
Bottle Oiler	Plain Bearings
Mechanical Force-Feed Oiler	Plain Bearings, Reciprocating Cylinders, Sliding Surfaces

"Continuous Use" Applications of Oils
(Flood Lubrication)

Circulation System	Plain, Anti-Friction Bearings, Gears
Ring, Collar or Chain	Plain Bearings
Splash	Plain and Anti-Friction Bearings, Gears, Eccentrics, Cams
Bath	Plain and Anti-Friction Bearings, Gears, Eccentrics, Cams

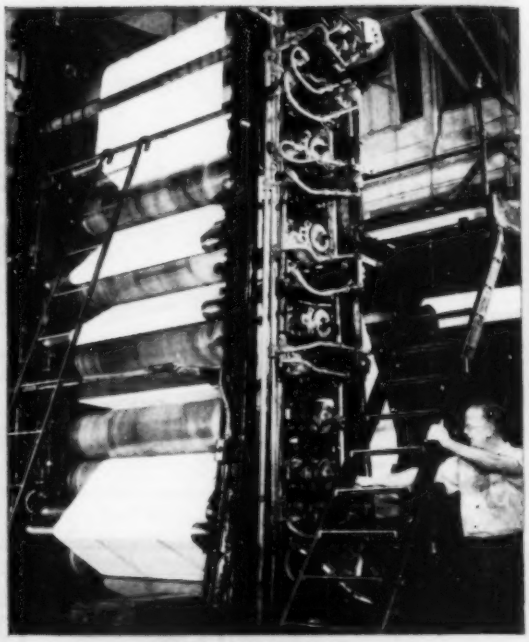


Fig. 1—"Once-through" method. These calender bearings receive lubrication by periodic application from an oil can. The oil goes through the bearing and is expended.

Proper Application of

BRUCE M. DUNHAM
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FROM THE USER STANDPOINT, the most logical method of purchasing lubricating oils is by the "time-temperature factor." This factor is dependent directly on the method of application. "Time" means the length of time a given quantity of oil must remain in a bearing, gear box or lubricating system. If a mechanical force-feed lubricator is used the oil to the bearing is soon lost, but the lubricator is constantly replacing the oil which has been lost. Here, the length of time that any given amount of oil stays in a bearing is relatively short. All methods of application of oil that allow it to remain only a short period of time without recovery are known as "once-through applications." These methods are listed in the accompanying table. Conversely, if the oil is brought back to the bearing repeatedly, as in a circulating system, the length of time the oil must provide lubrication is relatively long. The table also lists standard methods of application in which the oil is subjected to long-time use.

"Temperature" means the operating temperature of the oil in the bearing or other part. If the oil is fed to a compressor cylinder one drop at a time, then the oil temperature in the cylinder is assumed to be that of the cylinder and cylinder wall. If oil is circulated to a bearing at a given rate of flow, then the temperature can be assumed to be that measured at the immediate outlet of the bearing. In the latter case, if flow is increased temperature will drop.

The higher the operating temperature to which an oil is subjected, the more rapid is the rate of deterioration. One reasonably authentic source claims that the rate of oxidation or breakdown of an oil doubles for every 18 F rise above 140 F. Whether this is absolutely true or not, it does emphasize that low operating temperatures are desirable and equipment should be so designed that flow can be adequate, and the oil can act as a coolant as well as a lubricant.

What happens to a petroleum oil when it does break down? Briefly, this is what happens: The oil (1) forms sludges; (2) forms resins, varnishes or gums; (3) forms acids (corrosive and non corrosive); and (4) increases in viscosity or body.

The extent to which one or more of these products of deterioration forms depends on the quality of the oil, the time used and the temperature to which it is subjected. This deterioration is the direct cause of oxidation and is catalyzed in the presence of dirt, moisture and metals.

Three classifications of petroleum oils sold industrially today lubricate 90 percent of all industrial machines and

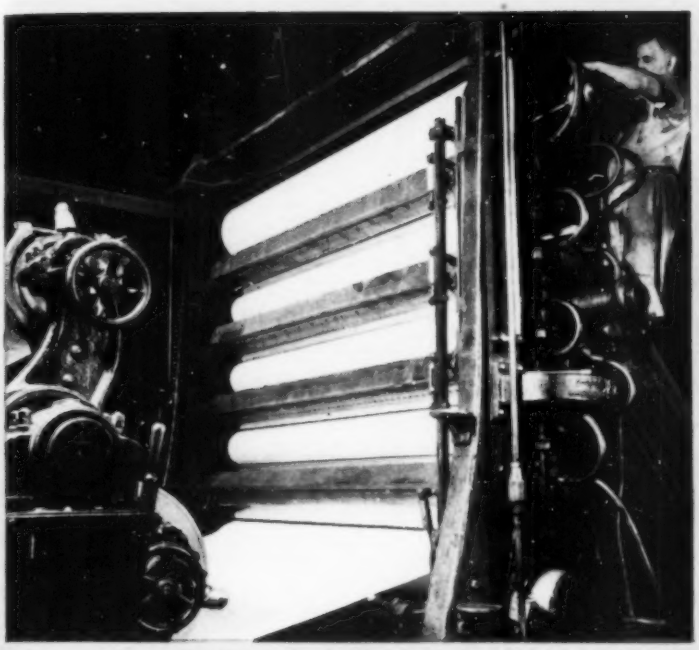


Fig. 2—These calender bearings are lubricated by continuously circulating oil from a central reservoir. The oil is used over and over again at a relatively high temperature. Best performance is attained by using a type "C" oil.

Lubricating Oils

are known as general lubricating oils. Most large oil suppliers distribute such grades. These are:

Lubricant "A": Straight distilled lubes from a variety of crudes. No supplementary treatment is employed.

Lubricant "B": Straight distilled lubes similar to "A" with further refinement in the form of dewaxing, acid-treatment, solvent treatment, or filtering and blending.

Lubricant "C": Distilled lubes with further refinement by solvent treatment, dewaxing, de-resining and filtering, plus addition of fortifying agents to reduce or eliminate oxidation, corrosion and/or rusting. (These are commonly known as "turbine quality oils.")

The accompanying curve shows a plot of the average useful life versus operating temperature of these types. This plot can be assumed to be reasonably accurate with respect to the comparable qualities of the reference oils. It does not hold, however, if large quantities of contaminents such as water, dust and/or cutting fluids enter the system. Data is based on eight hours per day operation with normal make-up of ten percent per year. The slope of the curves at any point shows rate of breakdown of the oil.

The curve for oil "A" indicates that this type oil can be safely used for "continuous service" up to 120 F. It is not recommended for this type service above 120 F, and the dotted portion of the curve extending to 150 F indicates rate of breakdown in this range. This oil, however, can be safely used at temperatures above 120 F by "once-through" methods of application, the main consideration being, that proper viscosity be utilized at the operating temperature.

The curve for oil "B" indicates its suitability for "continuous use" up to 150 F. Here again, the dotted extension to 280 F shows very short time use as temperature is increased, with possible danger of deleterious effect on machine parts caused by sludges, gums and corrosive acids. This type of oil, according to the plot, can be employed for a six month period where average operating temperature is 150 F, and for 24 months if the temperature averages 100 F. This curve, as well as the one for oil "A", is not carried further because the majority of industrial machines operate above 90 F temperatures.

The curve showing life characteristics at various operating temperatures for oil "C" has been broken after 24 months and resumed at 120 months, to include lower operating temperatures within reasonable space limitations. It will be noted that this quality oil has excellent time-temperature features. It can be used for higher temperatures and for longer periods of time than the other types. This indicates a high degree of stability. The trend is to incorporate "continuous use" methods.

If the use time at 120 F of these three oils are compared, it is seen that oil "A" can be employed six months, oil "B" for twelve months, and oil "C" for over 240 months (20 years), on the basis of eight hours per day operation and assuming freedom from excessive contamination. In addition to long-life, oil "C" is compounded to protect against rusting action. This is an important feature to the user.

From an economy standpoint, it is generally logical for the consumer to utilize an oil such as "A" for "once-through" (Fig. 1) applications and "C" for "continuous use" (Fig. 2) applications, requiring high stability. This practice has been proven to be the most economical in industry, considering both unit and overall lubricant costs.

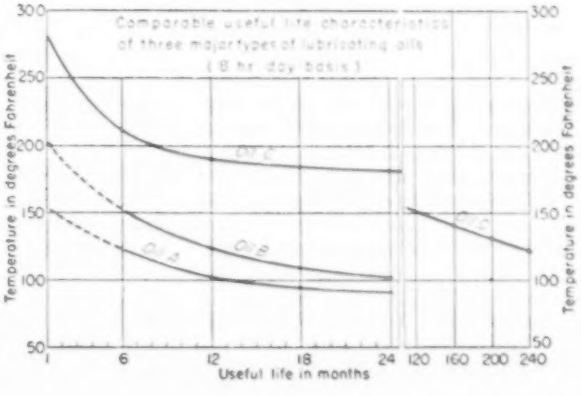
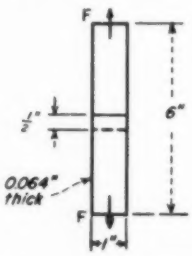
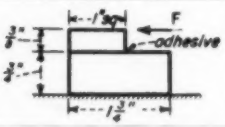


Table I — U.S. Air Force Requirements for Adhesive Bonded Joints

Type of Test	Test Specimen Material: Clad 24S-T3	Temperature Conditions	Minimum Strength	Rate of Loading	Number of Specimen
Shear		72 to 76 F 178 to 182 F −65 to −70 F	2,500 psi 1,250 psi 2,500 psi	600 to 700 psi per min.	3 3 3
Shear (after exposure)*		72 to 76 F	2,000 psi average		2 panels under each of the six conditions**
Long Time		72 to 76 F 178 to 182 F	1,600 psi 800 psi	duration of over 200 hr.; creep less than 2 times adhesive film thickness	15 15
Fatigue	same as above, but $\frac{5}{8}$ in. overlap	72 to 76 F −65 to −70 F	650 psi 650 psi	3,600 cycles per min. max.	15 15
Bend		72 to 76 F	150 lb	200 lb per min. max.	5
Impact		72 to 76 F −65 to −70 F	10 ft-lb 5 ft-lb	11 ft/sec maximum head velocity	5 5

* Separate exposures of: (1) 30 days in salt spray; or (2) immersed in tap water; (3) 7 days in Ethylene Glycol, (4) Anti-Icing Fluid (5) Hydraulic Fluid, or (6) Hydrocarbons.

** Each panel is cut into 5 specimens after exposure.

Why Consider Adhesive

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AS A RESULT OF EXTENSIVE RESEARCH and development work on metal adhesives during the past decade there are a number which have proven very successful. Test results have shown that this method is sufficiently strong to replace rivets and now certain aircraft structures are joined this way. In England, the *Comet, Dove* and *Meteor* have panels which are strengthened with adhesive-bonded stringers. In this country, almost one third of the surface of the B-36 is reinforced with members held by adhesives.

This type of assembly offers a solution to the problem of more efficient connections in thin, light weight structures. Eliminating the tedious process of drilling and riveting, bonding has shown a reduction in costs and also give much smoother surfaces, even in comparison with spot welds which leave slight indentations.

Although adhesive bonding was developed for extremely smooth surfaces, important in high-speed aircraft, such surfaces have excellent possibilities in many other products. For not only can dissimilar metals be joined together but other materials such as wood, cloth, glass and thermosetting plastics can be easily attached to metals.

Adhesives Have Many Advantages

In thin sheets, the strength of riveted joints is limited due to the low bearing strength of the metal, consequently the shear value of the rivets can rarely be developed. Bonding is the only way that thin sheets can be made to develop their full tensile strength. For example a 24S-T Alclad sheet less than 0.050 in. thick will fail in tension before a properly designed one-inch overlap adhesive bond. Bonded structures seldom fail in the bond during fatigue tests.

Adhesive bonds are resistant to salt-spray, humidity, and low temperature. Because of the nature of the aircraft structural applications, this type of joint has been subjected to extremely severe conditions before

Table II — Characteristics of Some Typical Metal Adhesives

	Tradename and Manufacturer	Composition and Curing Conditions		Remarks	Thickness of Joint inches	Typical Shear Strength with Aluminum Strips psi	Applications
A	*Araldite* Ciba Products Corp.	Ethoxyline Resin Type I powder or stick used like solder Type II Type 15 Type 101 two liquids	Slight pressure at 390 F for 1 hr. cold setting type	No pressure is required during bonding. Adhesive has a high tensile strength. Can be used for glass or ceramics.	0.001 to 0.006	4,500	Attaching vitreous-coated metal panels—Assembly of door and window frames—Cementing carbide tips in reamers.
B	*Cycleweld*** Chrysler Corp.	C-3 Phenolic rubber-base resin. CB-4 C-3 plus Nylon base	200 psi 325 F 15 to 20 min.	Good oil resistance of joints. Must be protected from salt spray.	0.003 to 0.006	4,000	Bonding aircraft sandwich construction; laminating metals. (A similar type is used to bond brake linings to metal drums.)
C	*Metlbond*** Narmco Inc.	M3c Phenolic synthetic rubber base MN3c M3c plus "Nelite" (a thermosetting plastic)	50 psi bonding pressure and cure at 325 F for 30 min.	Low bonding pressure permits use of atmospheric pressure.	0.005 to 0.020	3,000	Attaching reinforcing stringers to sheets. "Waffle" type sandwich construction.
D	*Redux*** Resinous Products & Chemical Co.	Liquid phenol-formaldehyde plus "formvar" powder	300-500 psi at 300 F for 15 min.	Good adhesive for aluminum alloys, stainless steel, magnesium, CR steel;—nickel & alloys, lead, copper not satisfactory	0.003 to 0.006	5,000	Aircraft surface reinforcing; wood to metal structural bending.
E	*Reanite* U.S. Stoneware Co.	Thermo-plastic and thermosetting resins	350 F for 10 min. at moderate pressure	Not recommended for shock loading.			

* In liquid form—brush, dip or sprayed.

** Approved for U. S. Air Force use per Spec 20044 and 14164

Bonded Structures?

Smoother joints • Economical to apply • High strength • Corrosion resistance • Dissimilar materials can be joined

approval. Table I illustrates the extensiveness of the U. S. Air Force requirements for adhesive bonded connections. To date only three adhesives satisfy these exacting conditions. They are listed in Table II.

Attaching different metals together is often a source of galvanic corrosion, particularly with aluminum and magnesium; such corrosion is prevented in a bonded joint since the adhesive separates the metal. This bond, usually a neophrene-phenolic or vinyl-phenolic resin, also serves as an electrical insulator.

In aircraft applications, weight is an extremely important factor. A product designer is also concerned with weight, for the cost of his product is directly affected by the weight of special alloys which may be required. Using adhesive bonded joints, extremely thin metals can be used. Heretofore, the thickness has been determined by the metal required for riveting or spot welding without distortion. Sheet aluminum and magnesium alloys as thin as 0.016" have been satisfactorily bonded. Metal films as thin as 0.002 in. have been used to make honeycomb-sandwich structures.

Basic Requirement of an Adhesive

One of the most important factors in an adhesive is its ability to cling to other materials, and this is affected by

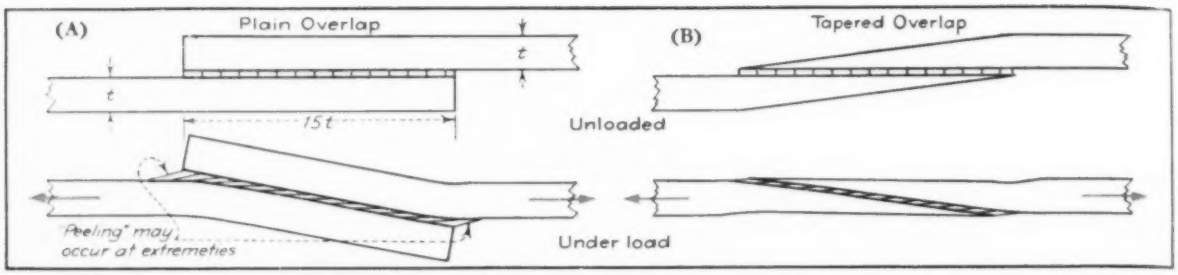


Fig. 1—Adhesives must be properly applied for maximum strength. (A) Plain lap joint has limited strength due to "peeling" which is caused by distortion. (B) Tapered edges improve stress distribution and mean higher tensile loads can be safely carried.

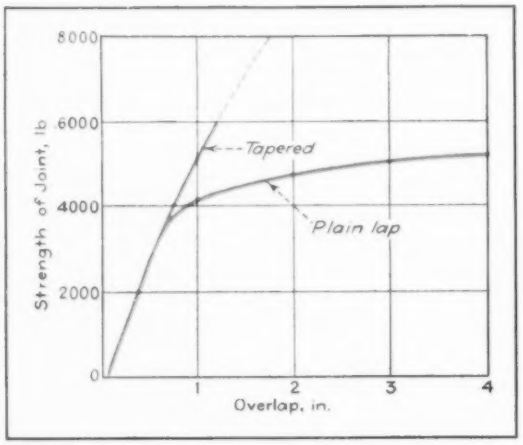


Fig. 2—Strength of plain lap joints is affected by the eccentricity which causes distortion. For maximum joint strength the metal should be tapered at the edges.

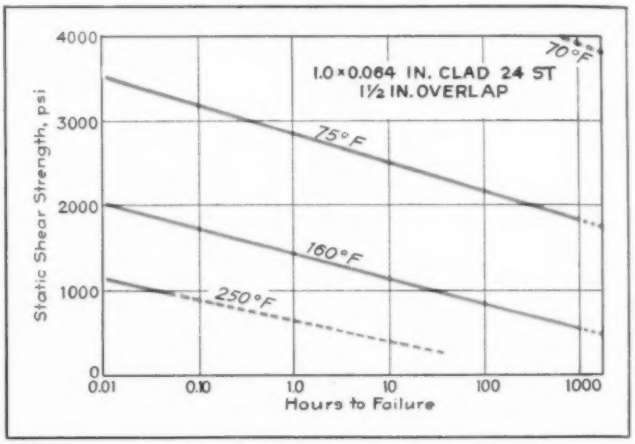


Fig. 3—Static strength of lap joint is affected by both temperature and time. Strength is determined by creep of the joint equal to twice the adhesive thickness. Curves are based on tests using Adhesive C, Table II.

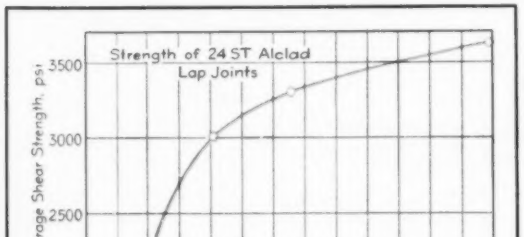


Fig. 4—Shear strength of bonded lap joints is affected by thickness of metal. Based on tests of Adhesive C, Table II.

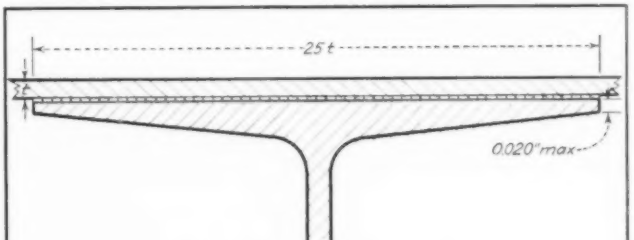


Fig. 5—Recommended proportions of sheet stiffeners for bonding. Tapered section prevents wrinkling and insures a smooth, strong joint.

the surface condition of the materials to be bonded: surfaces must be absolutely clean. This is necessary to insure a thorough wetting by the adhesive. This condition is similar to that which is required for painting or applying other surface coatings.

Besides the ability to adhere, a satisfactory adhesive must have certain other qualities. It must be capable of curing or solidifying, and it must have both rigidity and strength. The thermal coefficient of expansion is also important.

Use of high rigidity adhesives in shear joints causes the load to be carried by a small area due to the stretching of the bonded material. This results in a sharp stress concentration at the edges of the bond. Low modulus materials are not as strong and consequently deform under load. As a result, there is a more uniform loading over the bonded area. Adhesives have been produced with a proper balance of these factors. This can be seen in the high ultimate strength of the adhesives listed in Table II. However, it is to be noted in Table I that the shear strength of the bonded aluminum alloy is lower at higher temperatures. This is normal for many materials of an organic nature, whether in adhesive form, laminated sheets or molded shapes. In addition, there are residual stresses that exist between the bond and the metal, due to the temperature change and the difference in thermal expansion of the metal and adhesive. To minimize pre-stressing, the thermal coefficient should be held nearly identical to that of the material being bonded.

The low temperature strength of bonded joints is about equal to that of

joints tested at room temperature. This is probably due to the increase in rigidity of the adhesive as well as the residual stresses. Under these conditions the stress concentrations become a serious factor. As a result, the overall joint strength is not improved for applications at lower temperatures.

For most adhesives, the process of vulcanization produces the necessary solidification for bonding. In this process, the long chain-like molecules of the adhesives are chemically linked to neighboring chains by agents introduced for this purpose. Sulphur is used in natural rubber and in some synthetics. In others the metallic oxides perform this function much more effectively. The rate of vulcanization is greatly increased by heating and by the addition of small percentage of chemical accelerating agents. The physical nature of this solid adhesive is largely determined by the amount of vulcanizing agent employed and the time, temperature, and pressure during the process of curing. In general, an increase of any one of these results in a stiffer, less deformable bond and, if carried to extremes, may result in a joint which fails at low loads due to its inability to distribute these loads by local deformation.

When the resinous adhesives are employed, solidification is achieved by a process called polymerization which is somewhat akin to the action of crystalization of metals. This is a chemical process in which small molecules or groups of molecules join together in networks with links in random directions resulting in a rigid solid when the process is complete. This is brought about by mixing two materials, which possess certain chemical structures, in the presence of a catalytic agent and simultaneously raising the temperature and pressure. Solidification begins with certain molecules or groups and proceeds in all directions at rates which depend primarily upon the temperature but also to some extent on the catalyst and on the pressure. Polymerization probably begins at the surfaces (where the temperature is highest) and proceeds inwardly until all of the available molecules have taken their places in the structure or network.

Strength of Joints

A small, plain lap joint similar to that of Fig. 1(A) would require a certain tensile force to shear the joint. Doubling the area of the bond would not produce a joint twice as strong. This is due to distortion that takes place under load of members joined by lapping two materials together. This effect is graphically shown in Fig. 2. Metal distortion causes greater stresses at the extremities of the bond than at the center.

The amount of distortion is affected by: thickness and elasticity of the metal, tensile force, and length of overlap. Such distortion can be reduced by simply beveling or tapering the edges of the metal to be bonded as illustrated in Fig. 1(B). Thus the joint efficiency will increase since the adhesive stresses will be more uniform throughout the entire bond area. Such tapering is particularly important for gages over 0.040 in.

It should be evident that for the most effective use of adhesives, special design considerations must be taken into account. However, in most applications where adhesives have replaced rivets, no dimensional changes were made; yet the adhesive strength exceeded that of the riveted structure. This is probably due to the stress concentrations caused by the many drilled holes.

Significant Factors in Design

The strength of an adhesive bonded joint is determined by the design of the joint and it must be such that the manufacturing department can produce a satisfactory job. Joints should be accessible for application of pressure; either by jigs or vacuum bags. Materials to be bonded must tolerate the curing or bonding temperature, usually between 300 and 350 F for approximately 30 minutes without significant loss of strength or ductility and without distortion.

The most natural application of adhesive is where the units are flat. This simplifies the tooling required during the bonding operation. In the B-36, reinforcing stringers are bonded to flat sheets and this assembly is riveted to the bulkheads or ribs. In England, De Havilland uses a unique process where angles are first bonded to sheets and this unit is then wrapped around bulkheads or ribs to form the fuselage or wing.

Curved members can be adhesive bonded; but since there is the additional expense of a contoured pressure jig, such a process would depend upon the production quantities.

Certain bonded joints have improved strength at lower temperatures, conversely at higher temperatures (250 F), the static strength is greatly reduced. This relationship is shown in Fig. 3 and is based on 0.064 in. 24S-T Alclad joints 1.0 in. wide and with a $1\frac{1}{2}$ in. overlap using Adhesive C in Table II.

The average strength of a lap joint of the same material and adhesive but with metal of different thicknesses is given in Fig. 4. This chart as well as Table I make evident the large safety factor which is applied to bonded structures for aircraft purposes. Such safety factors are necessary since production parts have joints somewhat weaker than the laboratory joints which are listed in Table III. There is the inability to inspect a joint for

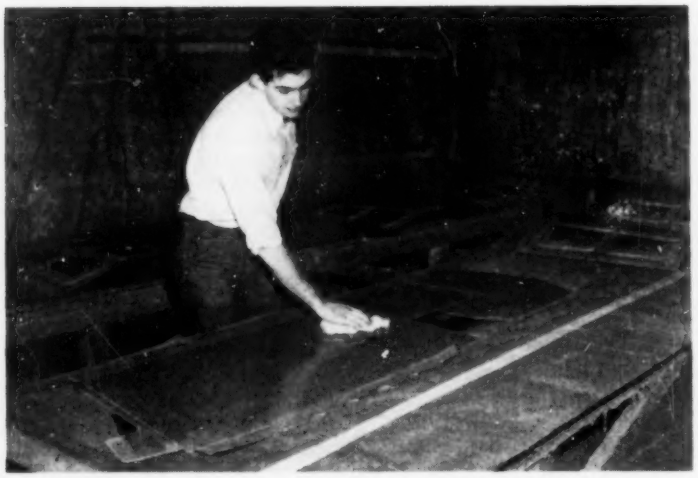
Tungsten-carbide cutting tips are held in reamer by Adhesive A, Table II. This method of attachment eliminates the need for machining close tolerances.

Table III—Shear Strengths of Aluminum and Magnesium Bonded Joints Using Adhesive "C" Tape (in psi)

Material	Design Value	Minimum Test Requirements	Test Conditions				Liquid Spray	
			Normal	Humidity[1]	Salt Spray[2]	Low Temperature[3]	Tap Water	Salt Spray
24S-T Alclad & Tape[4]	1,000	2,500	2,875	2,843	2,572	2,840	3,395	3,414
24S-T Alclad & Tape[5]	1,000	2,500	2,947	3,225	3,133	2,860		
FS-1h Magnesium & Tape[4]	250	750	867	973	713	1,200	1,052	969
FS-1h Magnesium & Tape[5]	250	750	880	945	840	1,120		

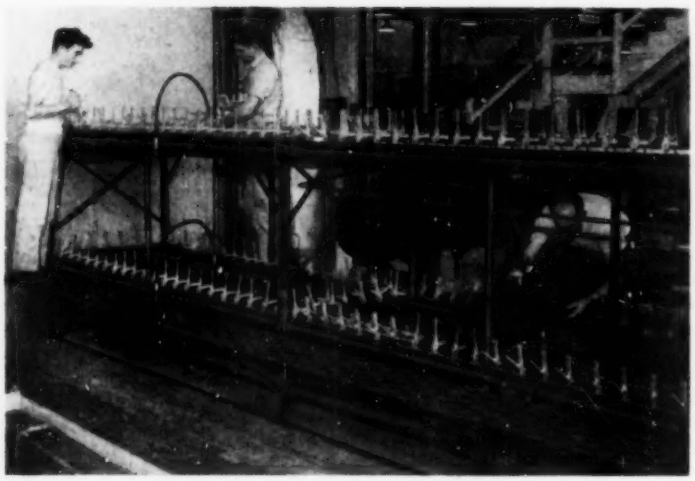
[1] 95 percent Relative Humidity at 120 F for 30 days
[2] According to Spec QQ-M-151a for 30 days
[3] −65 F for 14 days
[4] No. 108 Fiberglas Cloth
[5] Nylon cloth Spec. AN-C-127

How An Adhesive Bonded Joint Is Made



STEP 1—Surface preparation is an important step in securing good bonds —an absolutely clean surface is vitally necessary. Following the degreasing operation, all bonding surfaces are wiped with naphtha.

STEP 2—A priming adhesive coat is first sprayed on each surface to be bonded. Masking of the unbonded areas is often done for neater joints.



STEP 5—Rubber blanket covers jig and is evacuated for required pressure on bonded areas. Entire unit is then cured in heated oven at 325 F for 30 min.

STEP 6—Adhesive-bonded elevator panel is visually inspected following the curing operation.

strength without destroying the part; many different exposure conditions warrant the use of such high factors.

Note that magnesium has a much lower design stress. This is due to the priming coat of zinc chromate which is necessary to avoid corrosion. Whenever a coated or plated material is to be bonded, the design stress should be based on the weakest adhesive, whether it be the coating, plating or the adhesive. The overall strength is determined by the poorest adherent.

In designs where thin sheets are to be bonded over a length of six inches, the ends should be tack riveted. This will facilitate the handling and insure a dependable joint. Fig. 5 illustrates recommended proportions for metal bonding.

In bonding two metals with greatly different thermal coefficients of expansion, such as aluminum with steel, designs must be made with smaller bonding areas. For in cooling from the curing temperature, residual stresses will be set up which can cause large distortions. To counteract this, there are two steps which might be taken: (1) curing operation done at a lower temperature (and at a longer time) or (2) use adhesives which do not require heat. For materials with slightly different expansion rates, it may be necessary to cool bonded parts in jigs to avoid thermal distortions. This difference in thermal rate can be occasionally put to use by having the member with the higher rate surround the other; thus on cooling, a tighter joint will result.

For applications which are likely to be exposed to extreme humidity or water sprays, the edges of the adhesive bond should be coated with bitumastic paint, zinc chromate, or other flexible paints.

Bonding Procedure

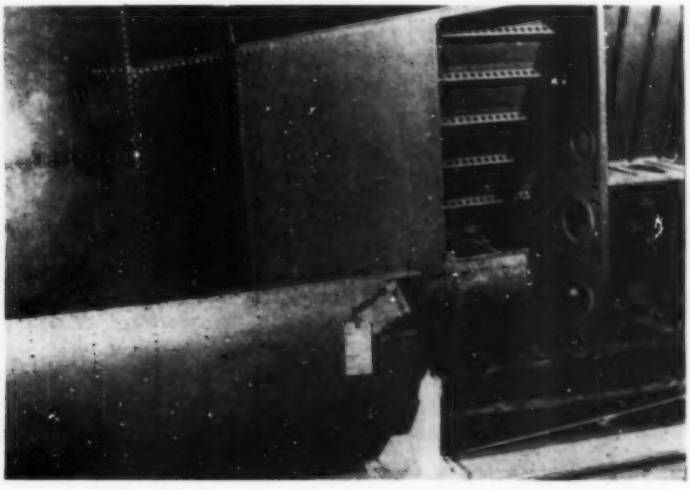
All metal surfaces to be bonded are first thoroughly cleaned of any oil, grease or other foreign materials. This may be done by a solvent wipe, vapor degreasing or an acid bath. A simple test of an adequately cleaned surface is that water should cover it in a continuous and unbroken layer. To prevent corrosion of magnesium alloys; following the cleaning, the surfaces are anodized, dipped in zinc chromate and dried.

Immediately before spraying the priming adhesive, all areas to be

STEP 3—Adhesive-coated tape is next attached to stringers which have been primed. Tape facilitates bonding procedure by eliminating additional spraying. Using this tape insures joints with uniform thickness of the adhesive.

STEP 4—Jigs are used to hold assembled parts together during bonding operation. Tack rivets at ends of stringer prevent peeling in handling.

CURVED COWL PANEL shows "waffle" type of stiffner that is used to reinforce thin sheets.



PARTIALLY ASSEMBLED view of Convair B-36 rudder shows the smooth external surface as a result of using adhesives to attach metal stringers.

bonded are wiped with a starch-free cloth soaked with a low aromatic content naptha. Workmen handling the cleaned metal must wear disposable white cotton gloves to avoid contamination. This priming application should be done as soon as possible following the cleaning operation. Intervals up to three hours between cleaning and supplying the adhesive may not be serious but overnight delays may affect the quality of the bond.

In applying an adhesive, it should be noted that each particular one has certain specific procedures to be followed. For best results, the manufacturer of the adhesive being used should be consulted.

Since bonded assemblies cannot be inspected after assembly, rigid quality control standards must be set up to insure consistently high-quality bonds. At Consolidated-Vultee Aircraft Corp. each assembly is inspected visually along the bead of flash with a thin feeler gage to probe and detect possible edge voids. If more than 5% of the bond length shows edge voids or defects, the part is rejected. Daily shear tests are also conducted on test specimens of aluminum alloy 24S-T strips 0.064 in. thick, 3 x 4 in. Specimens are bonded with a ½ in. overlap; three one-inch strips are cut from this specimen for test purposes. The shear strength must be at least 2,500 psi with evidence of cohesion over at least 75% of the area. This inspection procedure is outlined in U. S. Air Force Spec. No. 20044.

Each week specimens similar to the daily shear test strips are subjected to a 30 day salt spray test in accordance with Federal Specification QQ-M-151. First production assemblies and 1% of the following assemblies are pried apart at the bond for inspection. The bond must cover at least 75% of the bonded area.

Adhesive bonded structures are particularly insensitive to vibration and are strong from a fatigue standpoint. No fatigue failures have been encountered in the bonded assemblies of the B-36 or the Dove after thousands of hours of flying. This is particularly significant in view of the vibration of aircraft surfaces.

The continuous investigations and development work on such adhesives should provide designers with more data and further simplify this process to make it even more economical.

Designing to Meet SANITARY NEEDS

FRANK MITTELBERGER
New York, N. Y.

THE NUMBER OF MACHINES and equipment to which the principles of sanitary design must be applied is on the rise. Mainly, this is due to the increased production of food as well as to more exacting and more widespread public health laws. Another consideration is the popularity of packaged frozen and uncooked foods. These cannot be sterilized or pasteurized so equipment must be carefully designed to discourage contamination and bacteria formation. A similar requirement is common in the pharmaceutical industry, particularly in the field of the new antibiotics such as penicillin; and in the chemical industry, where contamination of the product cannot be tolerated.

Sanitary conditions in equipment are assured by:

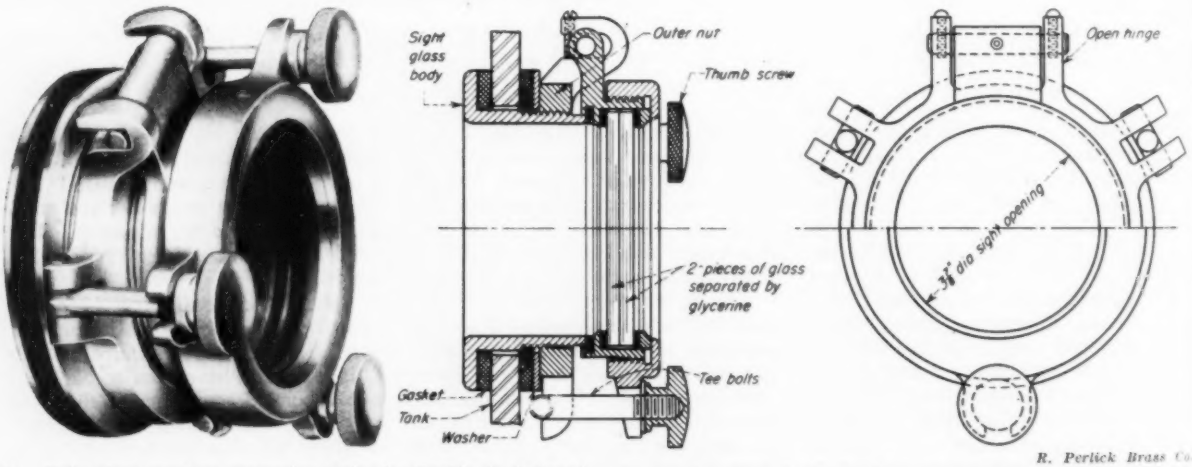
1. Proper selection of materials and finishes.
2. Providing protection against the entrance of foreign matter into the processing cycle.
3. Designing for quick disassembly by unskilled labor with a minimum of tools.
4. Avoiding dead spots, crevices, sharp corners, shoulders or packings where material can lodge.
5. Pitching pipe lines to assure complete drainage.

Material Selection

For each application the corrosion resistance of the material in relation to the food or chemical should be checked. This must be done to keep the surfaces free from rust and pits and to prevent the pick-up of contaminating metal traces by the foods or chemicals.

The use of dissimilar materials may lead to galvanic corrosion, depending on the pH of the liquid being processed. For this reason, the equipment and the connecting pipe lines and fittings should be made of the same material, unless past experience has proved the specific combination of metals harmless under identical processing conditions. The size of the metal areas exposed, the manner in which the metals are joined, and other conditions also have a bearing on galvanic corrosion. This point deserves particular investigation where aluminum is used in conjunction with other metals. Likewise, the combination of stainless steel with copper has in some cases resulted in galvanic corrosion and the pick-up of copper. However, there are other instances where no difficulties have been experienced with the same combination of metals. Because it is rather difficult to predict the occurrence of galvanic corrosion the use of dissimilar metals should be discouraged generally.

Austenitic stainless steels of the 18-8 series dominate the field of sanitary equipment. They combine corrosion resistance with high physical strength and surface hardness. AISI Type 304 with 18 percent chromium and 8 percent nickel is used in the majority of cases. However, for more critical applications type 316 with an addition of 2 or 3



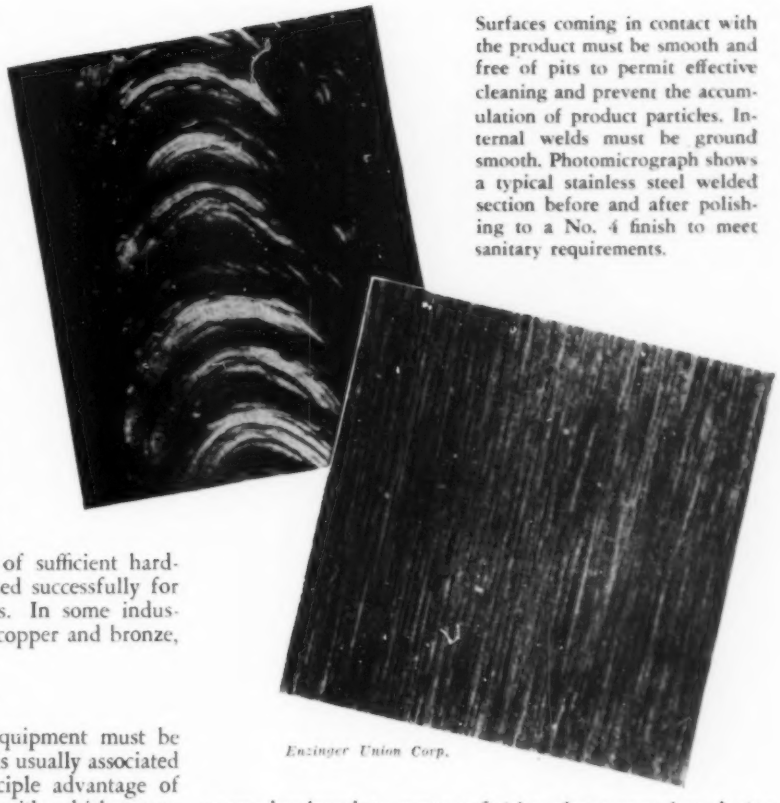
R. Perlick Brass Co.

1 Sight glass, used on processing tanks for liquids, is designed for quick disassembly. To open the sight glass for cleaning or other purpose, all that is required is the loosening of the thumb screws. The Tee-bolts swing back on open hinges and can be removed entirely if desired. The entire assembly consists of three main parts: the body, the outer nut cast integrally with the hinges, and the sight glass cover. Note that all threads are outside the tank and cannot come in contact with the liquid. For installation, only a plain round hole (4¾ in. in diameter) in the tank wall is required. This is especially advantageous with lined tanks.

percent molybdenum is preferred. Unless stainless steels of sufficiently low carbon content are used, annealing of welded structures is advisable under more corrosive conditions, due to possible carbide precipitation.

Monel metal with its higher heat conductivity and excellent ductility is applicable to sanitary installations in many cases. For packaging and also for storage and heat transfer equipment, aluminum is used because of its light weight, comparatively lower cost, and for good conductivity and ductility. Corrosion resistance generally improves with the purity of the aluminum.

Where there is little danger of mechanical injury and thermal shock, glass lined vessels are economical and sanitary. Certain phenolic resin coatings can be baked onto sandblasted steel surfaces where a somewhat lower surface hardness is acceptable. Rubber of sufficient hardness, and certain plastic materials are used successfully for gaskets, pipe lines and similar purposes. In some industries, there is no objection to the use of copper and bronze, which have the advantage of economy.



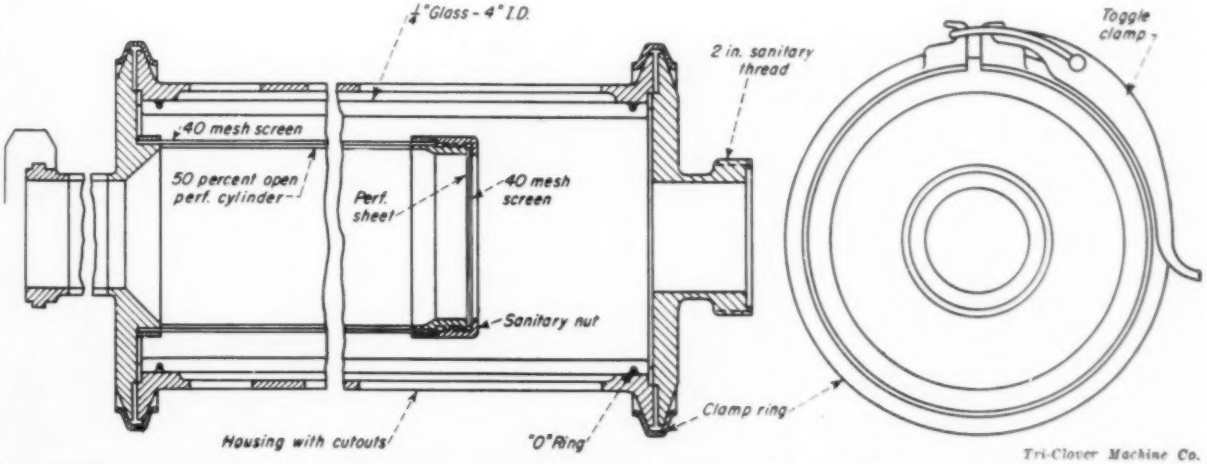
Surfaces coming in contact with the product must be smooth and free of pits to permit effective cleaning and prevent the accumulation of product particles. Internal welds must be ground smooth. Photomicrograph shows a typical stainless steel welded section before and after polishing to a No. 4 finish to meet sanitary requirements.

Enzinger Union Corp.

Surface Conditions

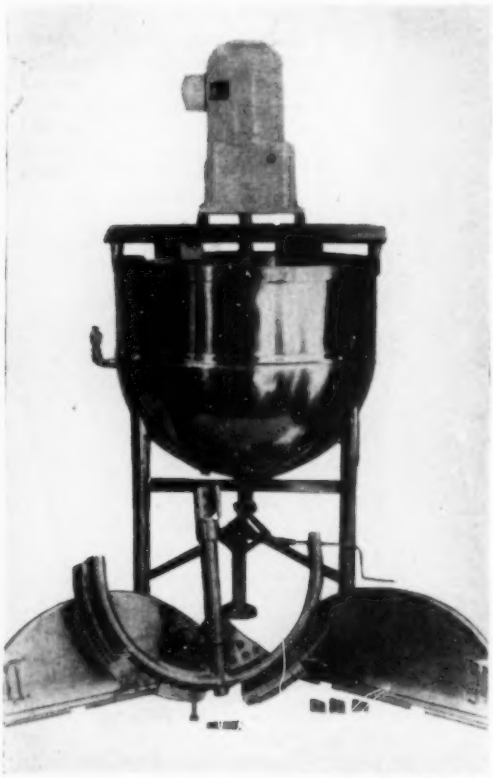
Obviously the surfaces of sanitary equipment must be smooth and free from pits. High luster is usually associated with smoothness, but actually the principle advantage of surfaces of high reflectivity is the ease with which superficial dirt can be recognized and removed. No. 4 finish of stainless steel is most widely used for sanitary equipment. It is produced by a fine grinding operation and has a high reflectivity, is pleasing to the eye, and facilitates the detection and removal of dirt.

Though certain methods, such as coating with plastics were developed to protect finishes from scratches during fabrication, minor scratches can hardly be avoided in the shops. The removal of these scratches is a costly operation, especially with the harder stainless steels. The emphasis put in some instances on perfect finishes without the least deviation is technically and economically unsound, because even a flawless finish cannot be maintained in this condition.



Tri-Clover Machine Co.

2 Combination sight glass and strainer for insertion in a pipe line. It is formed by a glass cylinder protected by a metal housing with large cutouts. The strainer is a perforated cylinder welded to the left flange and carrying a sanitary thread for the nut that secures the screen. The sight glass is disassembled by opening the toggle clamp. The strainer is taken apart simply by removing the nut, whereupon the tubular screen can be lifted from the perforated cylinder. At the same time, the perforated disk and screen at the end of the cylinder are freed. Screens of different mesh sizes can be used. *(continued on next page)*



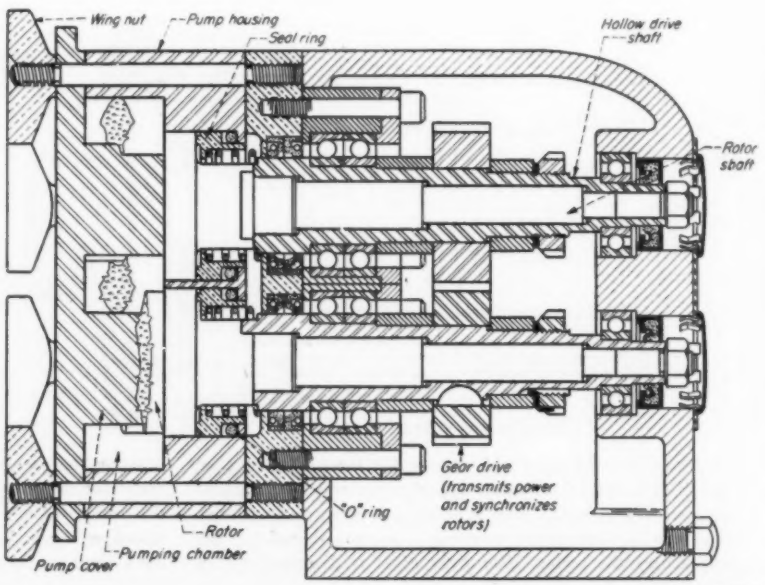
Groen Mfg. Co.

3 Processing kettle designed for easy removal of agitator, shown disassembled in foreground. Note fingers on agitator vanes for continual scraping of kettle walls. Motor is mounted above supporting pan that prevents lubricant from dropping into product.

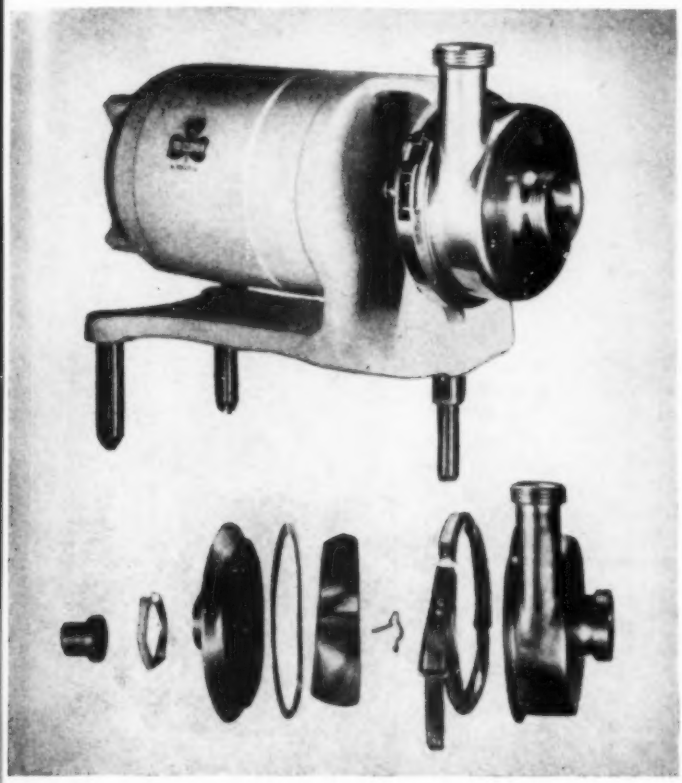
Tri-Clover Machine Co.

4 Galling or seizure of stainless steel sealing surfaces is eliminated in this lift-plug valve. Handle must be lifted before turning. When this is done, the pivoted handle cams against the top plate, thereby raising plug from its seat. Plug does not bear against the seat. The Belleville spring below the valve body assures tight reseating of plug.

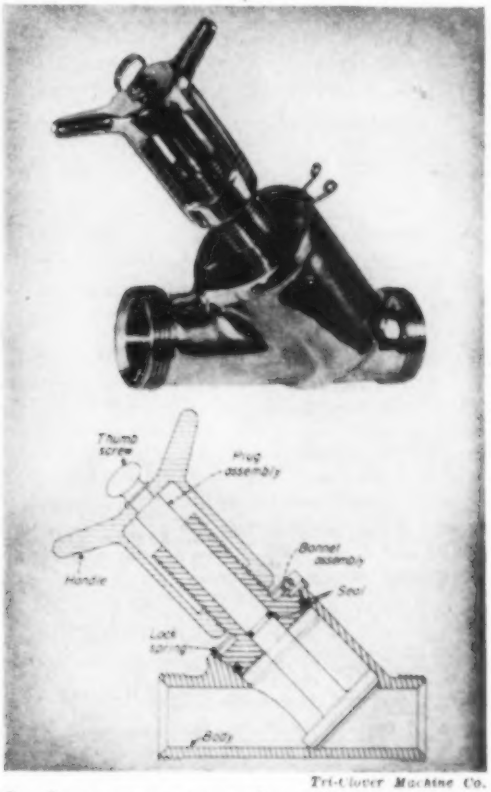
7 Sanitary positive displacement pump. Pump cover can be removed by unscrewing six over-size wing nuts. Rotors with their integral shafts are withdrawn from the hollow drive shaft after removal of the nuts at right ends of shafts. A cavity with a drain hole at the bottom completely divorces the pumping chamber from the gear drive, which runs in an oil bath. This prevents entrance of lubricant into the pump chamber or admission of product into gear drive. The rotary seal consists of a hardened stainless steel or graphite seal ring bearing against the rotating face of the pump rotor. The helical spring, providing sealing pressure, is located outside the pumping chamber. Side leakage is stopped by an "O"-ring between the housing and the seal ring. Note that gear drive synchronizes rotors, preventing metal-to-metal contact. This assures a set clearance between rotors for constantly maintained pump capacity.



Waterous Company

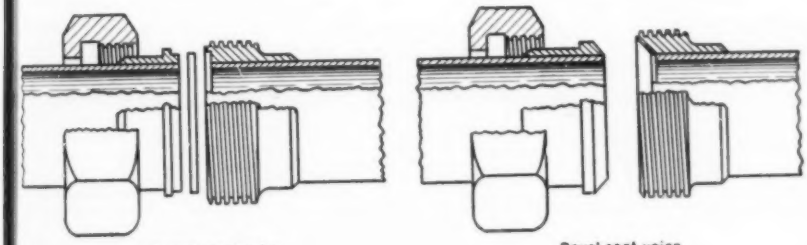


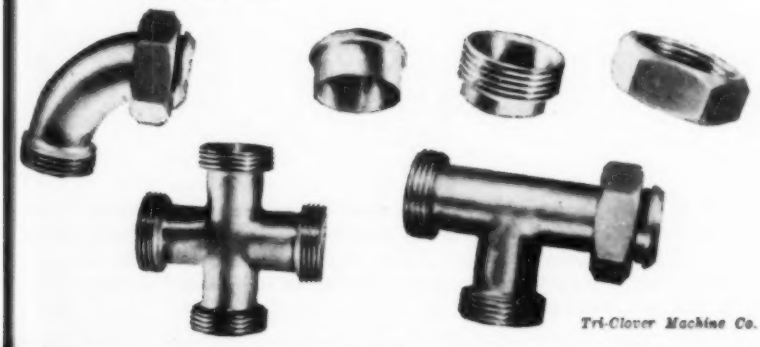
5 Centrifugal pump is opened simply by means of the toggle clamp. The impeller is then accessible and is freed by removing the snap-type lock ring. Flanged motor is mounted on the same base as the pump. Ball type feet simplify cleaning of floor. Pump housing can be turned for any desired position of discharge connection.



Tri-Clover Machine Co.

6 Operator can remove plug and bonnet assembly of straight-way compression valve after squeezing lock spring and lifting it from its groove. Removable "O" rings are employed for sealing. Note sanitary threads on valve body and bonnet assembly.

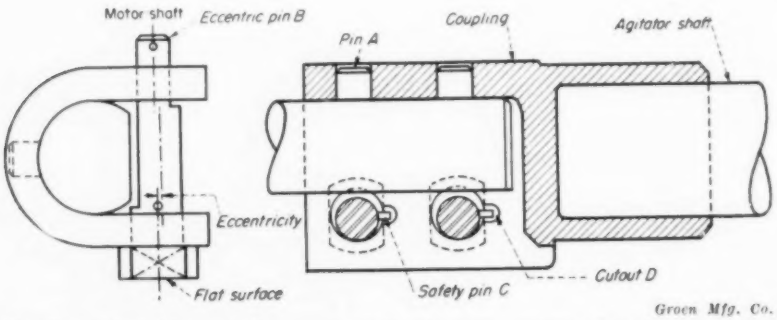




Tri-Clover Machine Co.

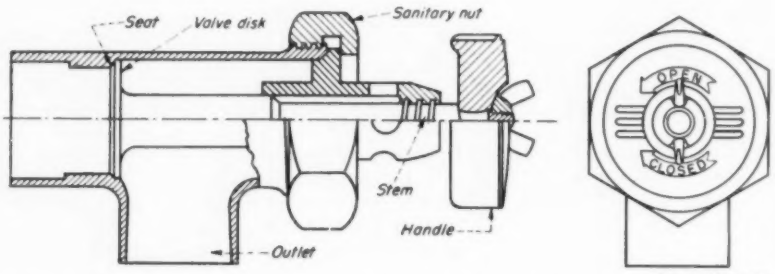
8 Special fittings were developed for sanitary installations. The usual iron pipe system employs internal, tapered threads, a portion of which are exposed after the joints have been tightened. The liquid within the pipes comes in contact with these threads and may lodge there and decompose. Only unions are used in sanitary pipe lines. The bevel seat union and the gasket seat union are common. The nut and the threaded ferrule carry an Acme thread (8 threads per in.) which is easily cleaned and suitable for repeated disassembly. Also, there is no danger of stripping threads, such as can occur with sharp V-threads. The tubing is inserted into the ferrule, cut flush with its face and then rolled in, welded or brazed. Thus, no dead spot exists between ends of the tubing. Piping so designed is free from crevises, is easily flushed out and disassembled. Relief and check valves are available with this type thread.

(continued on next page)



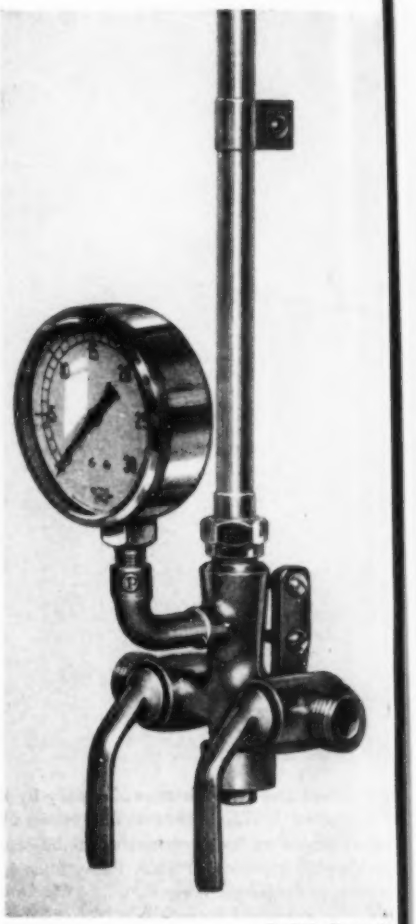
Groen Mfg. Co.

9 One end of this quick-disconnect coupling is permanently attached to the agitator shaft of picture 3. The other end forms a U shape into which the motor shaft is inserted sideways. Radial pins *A* transmit torque. Eccentric pins *B* are put into the coupling and turned, thereby tightening the whole assembly. The heads of these pins have flats for tightening by means of a wrench. Safety pins *C* prevent disconnection. Removal is accomplished by turning the eccentric pins until the safety pins match the cutout D in the coupling. Then the eccentric pins can be withdrawn. With this design, accidental disconnection of the driven shaft is impossible. Perfect alignment between driving and driven shafts is assured with eccentric pins tightened. Driving shaft and motor need not be disturbed.



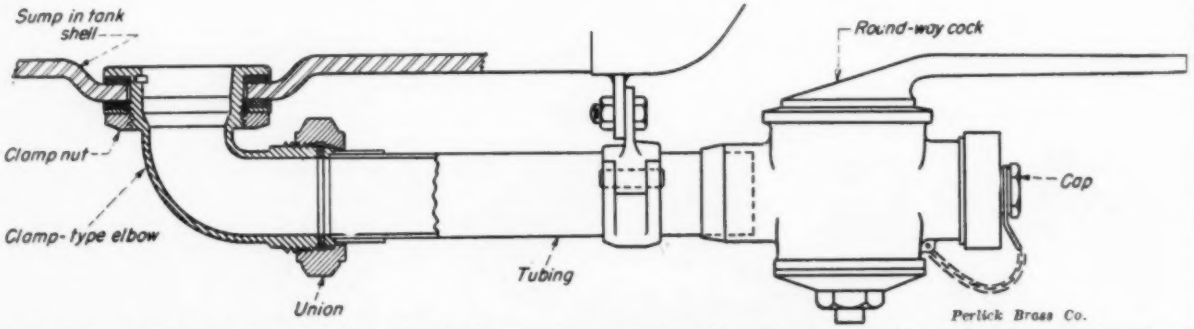
Groen Mfg. Co.

10 Quick-opening tank outlet valve is welded to tank or kettle bottom. Valve is opened by turning handle two or three times until it is free of the threads, then pulling the valve stem outward. To disassemble for cleaning, the wing nut is loosened and the sanitary nut removed, whereupon the valve components come free. This valve is suited particularly for fully-opened or fully-closed conditions.



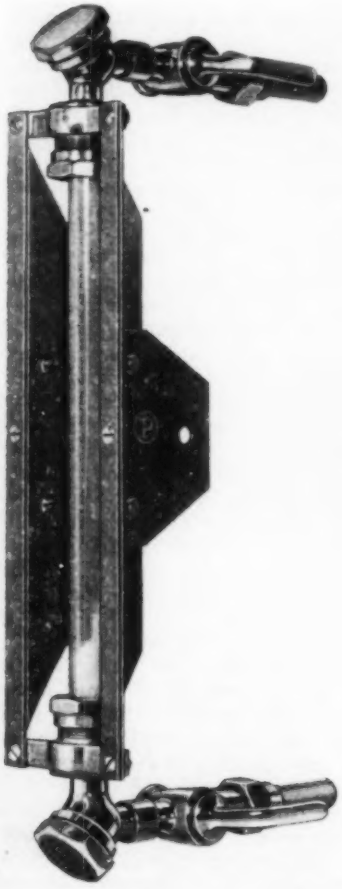
Perlick Brass Co.

11 Cross valve assembly and pressure gage has clean-out cap at bottom. Turning round-way cocks to the open position completes a straight horizontal bore through which a brush can be passed.



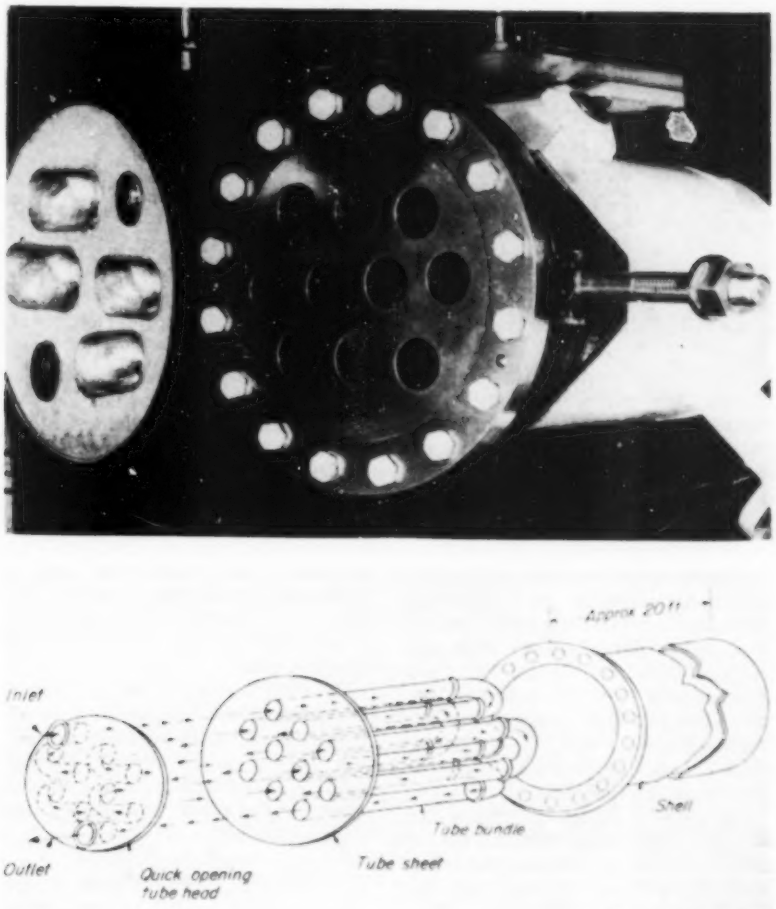
Perlick Brass Co.

14 Outlet assembly of a type mainly used by the fermentation industries. Note absence of shoulders or crevices in outlet line, which can be brushed clean by removal of the end cap. Sump in tank body assures complete drainage. In this case, clamp type outlet elbow is removable by loosening clamp nut and disconnecting tubing. For more exacting requirements, a sanitary ferrule, welded to the tank, replaces the elbow, thus eliminating all pockets. Supporting bracket of assembly at right is bolted to the tank. It can easily be opened when it is desired to remove cock and tubing.



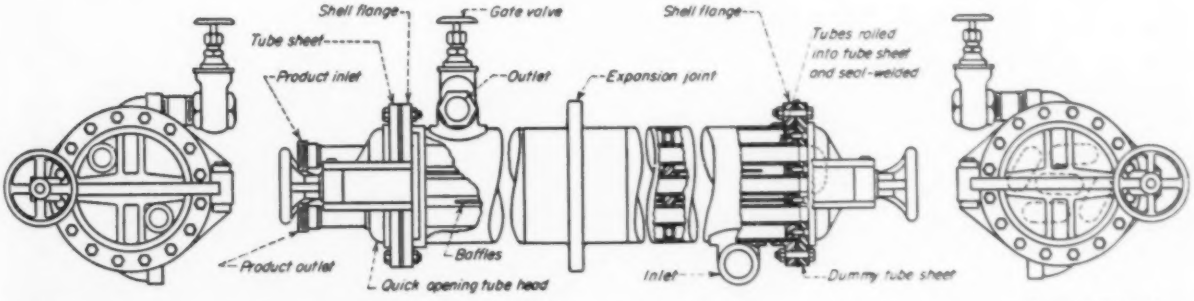
Perfect Brass Co.

12 Forty-five degree clean-out caps and round-way cocks permit cleaning of tank level gage and horizontal feed lines. Strategically placed unions make for easy disassembly of the installation.



Ensinger Union Corp.

13 Multi-tube heat exchanger having all tubes connected in series. This assures positive cleaning with disinfecting solution or brush ball. Return bends and tubes are of same diameter with no shoulders or crevices. Hinged head can be opened by untightening a single bolt having an Acme type thread. In some cases, removable heads are used on both ends of exchanger, as shown below.



Ensinger Union Corp.

15 Multi-tube heat exchanger with a quick-opening tube head on both ends. Note horizontal baffles on shell side, keep incoming fluid in longest possible thermal contact with the outgoing product. This assures a close approach of terminal temperatures. The tube bundle is removed from right to left. To make this possible, the right tube sheet is smaller in diameter than shell. The unit is kept liquid-tight by bolting the tube sheet to a dummy tube sheet which in turn is secured to the shell flange. Note that the differential expansion is taken up by single bellows expansion joint, which is of all metal construction.

TECHNICAL NEWS

Disagreement Looms on Drafting Engineers

WASHINGTON—Selective Service officials, the technical societies, and educators are in mutual disagreement as to draft deferring policies for college students and technicians. This is how they stand.

Interdepartmental Committee

Deferment of virtually all college students in scientific and engineering fields and removal of the drafting of scientists and engineers from the hands of Selective Service has been recommended to the President by the Interdepartmental Committee on Scientific Research and Development, which represents various interested branches of the government.

The Armed Forces committee did not go along with civilian agency members in the recommendations. Defense Department representatives abstained because of differences within the department between personnel officials, who must maintain an armed force of 3,000,000 men with only 1,050,000 turning 19 each year, and logistics officials who must supply that armed force with the latest technical advances in weapons and therefore want scientific manpower deferred.

The committee suggested that: A National Scientific Service be established as soon as possible. All scientists and engineers, including students in training, be registered in order to provide a basis for enrollment in the National Scientific Service. A Scientific Resources Committee be established under the National Security Resources Board to be responsible for plans and decisions on scientific manpower resources.

Selective Service Officials

Director Lewis B. Hershey and advocates of Universal Military Service do not agree with this recommendation. They claim that by deferring students in specific fields, such as science and engineering, the committee is going back to a World War II idea that did not work very well.

Following the recommendations of six advisory committees representing most fields of learning, Hershey calls for deferment on high level of study. Deferment from military service would be given to superior ability students in all fields instead of being reserved for science and engineering majors in general. Local boards, rather than a National Scientific Service, should do the drafting for everybody, the General thinks.

"If we let bankers draft bankers and farmers draft farmers, how many do you think would be drafted?" he asks. "These people are all citizens first. In a democracy, their fellow citizens on the draft boards can make the decisions."

Educators and Societies

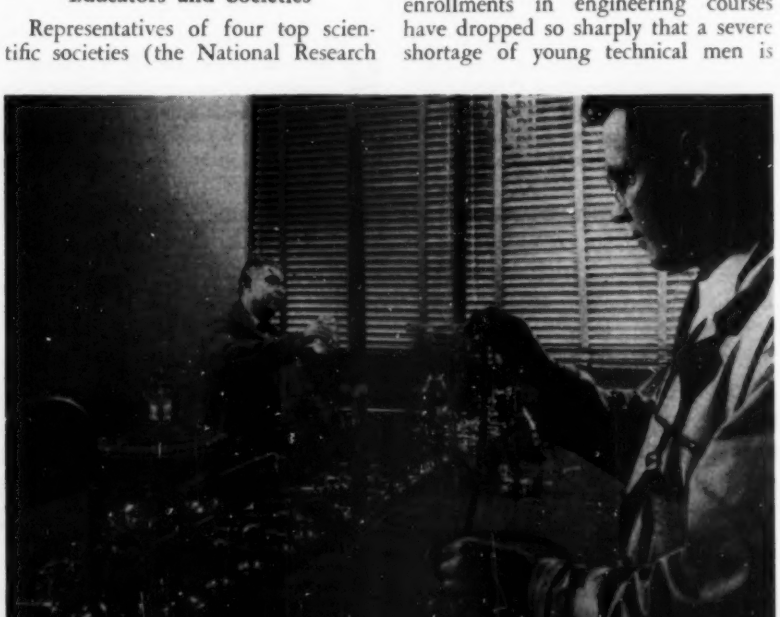
Representatives of four top scientific societies (the National Research Council, the American Chemical Society, the American Institute of Physics and the Engineers Joint Council) recommend that a separate body of experts in the fields to be deferred be set up to determine policy. Selective Service boards would follow their recommendations. This would scuttle Hershey's home rule plan of giving the say to local boards.

Three main points in the recommendations of the Selective Service advisory committees met with the agreement of the American Council on Education, however. The 550 educators and scientists thought that:

1. A nationwide aptitude test should be given to all high school seniors. Those who passed should be deferred to go to college.
2. Certain percentages of sophomore, junior, senior and graduate classes in universities and colleges should also be deferred.
3. No attempt should be made to pick out essential areas of study, because of uncertainty as to what will be essential to the national interest in five or ten years.

In order to allay suspicions that a privileged status was being sought for students and scientists, the meeting passed a resolution that any man who is deferred to complete his studies has an obligation to use his training in the national interest.

An ominous note is sounded by a recent survey of the American Society for Engineering Education. College enrollments in engineering courses have dropped so sharply that a severe shortage of young technical men is



General Electric Company

seen in the near future. The society estimates that a minimum of 30,000 engineering graduates are needed yearly by civilian industry alone. In the next few years graduating classes are expected to total: 1951, 33,500; 1952, 21,900; 1953, 17,000; and 1954, 12,400. Even without the inroads of military service, the situation will be dangerously acute in five years. Drafting of engineers would decrease supply even further.

Hot Spraying of Lacquer Increasing Rapidly

ONE OF THE FAST GROWING THINGS in the finishing field today is hot-spray application of lacquers to increase the thickness applied per coat. According to engineers at the Hercules Powder Co., lacquer seems destined to take over an increasing share of the automotive market with the hot spray process.

In the early 20's, most automobiles were enamel finished. By 1932 the market had swung almost entirely to lacquer. New developments reversed the trend again however, and today manufacturers are about evenly split between lacquer and synthetic enamel.

Enamel costs are lower and no polishing is necessary, while cold-sprayed lacquer must be applied in three coats and mechanically polished for a high lustor. Advantages of lacquers are that they are air dried without costly baking ovens and can be spot patched more easily than enamels.

With the hot-spray process, lacquer thickness per coat is increased to 2.2 mils over the 7/10 mil maximum with cold spraying. Two hot-spray coats are used where three were formerly required. Although the lacquer finish must still be polished, the operation is not so critical and costs are lower.

Inventors Told "There's A War On" But Patent Office Lags

THE NATIONAL INVENTORS COUNCIL held its tenth anniversary meeting in Washington recently to discuss how America's inventors and designers can best aid the government in the present crisis. A doubling in recent weeks in the number of mailed suggestions on how to win the war with the sender's invention or idea indicated that the nation's inventors—amateur or professional—were also aware of Korea.

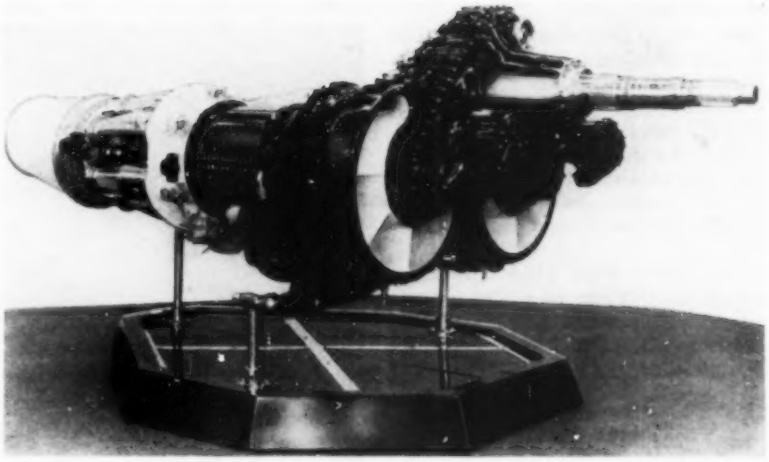
In the background, however, the spectre of unprocessed patent applications haunts the U. S. Patent Office, the official government agency charged with stimulating invention. The Council, a volunteer group of top American scientists and engineeers, was created in 1940 to act as a link between American inventors and military and other federal agencies with problems requiring technical solution. Its chairman is Dr. Charles F. Kettering.

Periodically, after consultation with the military, the Council circulates to interested inventors lists covering inventive problems currently of particular importance. The last lists released, for example, included a number of problems relating to arctic operation, such as the need for non-corrosive, extreme low-temperature snow-melting chemicals; low-temperature automotive-type batteries and convenient dry battery heaters.

About 25 percent of the 500 problems posed to the nation's inventors during World War II have been solved. About 250,000 suggestions and ideas were received, and 150 were finally used by the military services. The low figure is not indicative, however. One of these 150 was the magnetic land mine detector used extensively to locate buried mines. It saved thousands of lives. Another item was the mine destroyer tank. This is basically a flail-like attachment fastened to the front of a tank. Loose chains hit the ground and exploded the non-metallic type mines used during the latter stages of the war which the magnetic mine detector couldn't locate.

Dr. Kettering said that the Council now has 12 committees at work screening inventions. They are coming in at the rate of 80 per week—double that of several weeks ago. Korea did it. But while inviting inventors to submit ideas, inventors have not been getting a "break" from Uncle Sam's Patent Office. According to Patent Commissioner John A. Marzall, a member of the Council, there are 243,000 patent applications on file in the Patent Office.

This quarter-million backlog has



DOUBLE MAMBA TURBO-PROP ENGINE to be produced by Wright Aeronautical in this country consists of two turbo power sections which drive two co-axial contra-rotating propellers through a reduction gearing system.

Wright Aeronautical to Build British Engines

A NEW SERIES of propeller turbine and turbo-jet airplane engines have been added to Wright Aeronautical's line of piston engines and turbo-cyclone compound engines through an engineering and technical collaboration agreement between the American company and Armstrong Siddeley Motors, Ltd., of Great Britain.

This agreement covers more than specific engines. By pooling research, engineering and manufacturing teams, it will speed up production and development and eliminate certain duplications between the two North Atlantic allies. End results will be available for introduction in items now under contract for the U. S. Air Force as well as for commercial operators.

Four new gas turbine power plants will be built in the United States. The Sapphire turbo-jet, rated at 7,220 lb static thrust, has passed 150 hour service tests and is now flying in British Meteor 8. The 4,000 shaft hp Python turbo-prop is now in production in England. Mamba and Double Mamba turbo-prop engines, rated at 1,450 and 2,873 equivalent shaft hp respectively, are now in service in England.

been worked on for several years, but is not diminishing. Normally, a backlog of 160,000 is considered a "workable backlog". Efforts at cutting the backlog to workable size have been under way since 1946. Generally, most observers believe the Patent Office is understaffed for the work it is called on to do. Some blame it on inefficiency.

The future looks bleak for patent applicants. Right now Congress is considering a 10 percent cut in Patent Office appropriations.

Railroad Car Designed On Aircraft Principles

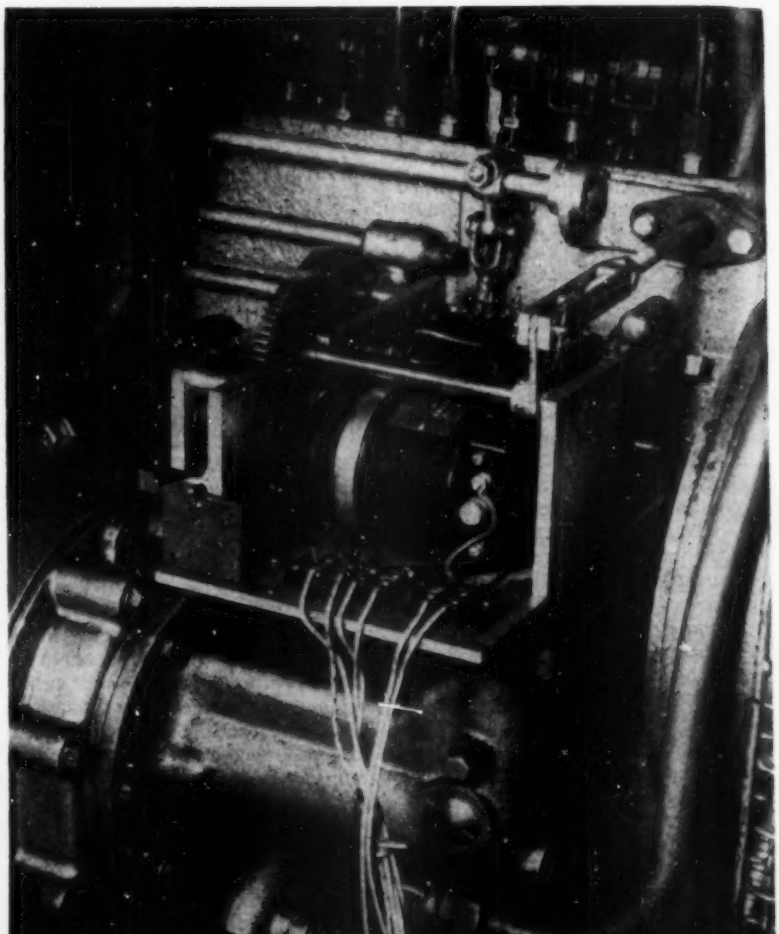
THE PRESSED STEEL CAR COMPANY'S NEW UNICEL RAILROAD CAR is made of plywood, shaped and bonded with electronic high-frequency heat and special plastic resins. There is no heavy steel underframe; the one piece car is essentially a hollow beam that carries itself. The whole structure takes static and impact loads like an airplane skin.

The Unicel is stronger than a comparable steel car. Under test at the Armour Research Institute it showed considerably more impact strength. Concentrated forces up to 50,000 psi are allowed in steel cars; largest stress the Unicel has to handle at any one point is 3,000 psi. It is cheaper and requires fewer manhours to build than steel cars. A "cold wall" air space between inner and outer skins permits conversion to refrigeration. Only 5 to 15 percent of the cold air goes into car, the remainder being pumped between walls.

The wood is bonded with specially developed resins which set under heat in a 150-200 psi press. Parts are shaped as they are bonded. Piles of wood, laid with grain at right angles and bonded together, develop higher strengths than individual plies. Tests made by the U. S. Forest Laboratory show that the phenolic bond can withstand unlimited wetting and drying and millions of vibrations.

Plastic coatings for the outside of car can be bonded during the same processing. The exposed surface veneers receive a layer of masking stock on top of which is bonded a phenolic resin-impregnated paper with suitable stenciling and coloring. The finished car is never repainted.

To cushion impact, Pressed Steel has developed a coupling gear containing laminated rubber cushions. The car itself is 30 percent lighter than steel models.



Navy Develops Electric Governor

THE U. S. NAVAL ENGINEERING EXPERIMENT STATION at Annapolis, Maryland is working on the development of an electric governor which is expected to permit faster and more constant speed control of small generating plants.

The main advantage an electric governor has over the conventional mechanical governor is its inherently faster response to change in load. For example, if an electric governor were installed on a portable generator which supplied power for communications and other equipment in the field, communications would not be interrupted if say an electric motor or searchlight were turned on. The electric governor would immediately respond to the additional load on the circuit and open the engine throttle before a lag in speed occurred.

Under the same circumstances, the response of the usual mechanical governor would be slower, resulting in possible interference with communications. A mechanical governor depends on the actual change in speed of the generator before going into action. In other words, the engine would slow down and produce a change in frequency before the mechanical governor could bring it back to speed.

With an electrical governor, any change in load current initiates immediate corrective action at the throttle, permitting an engine to return to the pre-set speed in the shortest possible time. It also enables the speed of generating machinery to be held more constant for all values of load.

The development contract at the Station calls for the electric governor to restore engine speed and frequency to within $\frac{1}{2}$ to 1 percent within $\frac{1}{2}$ second after a change from zero to 100 percent load and to maintain a steady load speed within $\frac{1}{4}$ of 1 percent. While developments are not complete, tests indicate that these limits can be reduced.

Basically the electric governor has

three actuating elements, a frequency detector circuit which can be set for the desired speed, a damping or anti-hunting circuit which stabilizes the operation and a load responsive circuit which is actuated by changes in generator current. The resultant output of these circuits is amplified and fed into a servo motor which controls the throttle.

The rapidly growing use of automatic electric and electronic safety control and communication equipment at airports and many military locations has greatly emphasized the need for portable or emergency power sources. The frequency of these units must be controlled just as closely as that of large central power systems. When a hurricane, for instance, cuts off the main power system at an airport, the importance of reliable emergency power units cannot be overemphasized. Electric governors will underwrite the reliability of equipment.

General Electric Opens Measurements Lab

LYNN, MASS.—The General Electric Company today officially opened its new measurements laboratory, believed to be the most modern and best equipped of its kind in the world. The new laboratory, staffed by engineering specialists in magnetism, electricity, chemistry, metallurgy, sound, heat, light and color, contains complete facilities for applied research, product development and design in the field of measurement. The five-story brick, steel and concrete building contains 142,000 square feet of floor space, the major portion of which is occupied by the laboratory and associated engineering groups, the remainder by administrative staffs of the G-E Meter and Instrument Divisions.

Two major objectives guided the company in designing and equipping the new laboratory: (1) to provide the best possible tools for the staff of more than 300 measurement specialists; and (2) to remove all physical barriers from coordination and integration of their work.

Work areas for the three major functional laboratory groups—the Advanced Engineering, Materials and Processes, and General Service sections—have been allotted on the basis of their special space and equipment requirements, and to assure the free flow of ideas and information among them. Each of these major sections is, in effect, composed of separate, smaller laboratories and work areas, each completely equipped and self-contained, and each specializing in a different phase of the science of measurement, ranging from pure research into metals to evaluation of new product designs.

Unlimited mechanical and electrical services have been made available to all work areas through a complete system of pipes and bus ducts suspended from the corridor ceilings. Mechanical services include hot and cold water, vacuum, process steam, nitrogen, oxygen, high-pressure air, city gas, and, to two areas where it is used in quantity, low-pressure air.

The Advanced Engineering sections, responsible for mechanical and electrical development associated with watthour meters, demand meters, instrument transformers, electric instruments of all kinds, aircraft instruments and time switches occupy more than one floor of the laboratory proper. Completely separated from other engineering personnel, these specialists work in semi-private cubicles equipped with work benches, easily accessible to all services, mechanical and electrical.

The Materials and Processes sections develop and evaluate the new materials which permit development engineers to expand their horizons to new measurements and new concepts of measurement devices. A metallurgical laboratory, equipped with metallographic-, radiographic-, tensile- and hardness-testing equipment, enables specialists to "see into" metals and metal-alloys to determine their physical and electrical properties. In another area, special furnaces permit the development and evaluation of the properties of measurements alloys under wide ranges of temperature.

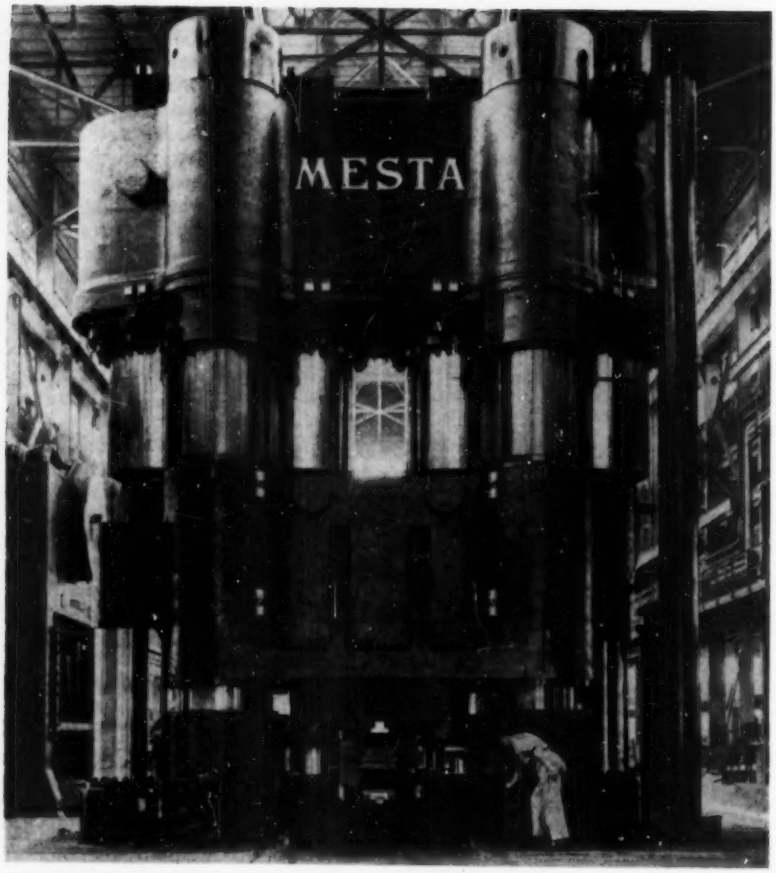
In an adjacent area, the life and suitability of various insulations and finishes are evaluated in a battery of heat-aging ovens, salt-spray baths, humidity chambers, "weatherometers," and "fadometers."

The General Service sections operate a multitude of experimental test facilities to evaluate the designs created by development engineers. At the heart of these test facilities are eight steel-lined "hot, cold, and humidity" boxes for testing instruments.

Specialists assigned to this group put measurement products through high-current and voltage tests; accelerated life tests, indoor and out; mechanical tests under conditions of shock and vibration; and "noise" tests in a "quiet" room where the barely perceptible noise of an electric-clock motor can be evaluated.

A "bread-board model" design, developed, evaluated and tested by the three main laboratory groups, goes to the division's design engineering group where complete design details are worked out. Once designed, prototype models are built and sent back to the laboratory's Service section for evaluation. If approved, the product is released for tooling and manufacture, and again it must pass the laboratory's evaluation specialists.

ENGINEERS in the new General Electric Measurements Laboratory shown putting development instruments through electrical tests at a harmonic generator, xariable frequency, and d-c power supply control board.



AN 18,000 TON PRESS at the Wyman Gordon Company in Worcester, Mass. makes the forgings for the Chance Vought Cutlass main wing beam.

Main Wing Beam Forged for Cutlass

SOME OF THE LARGEST PRESS FORGINGS ever made in the U. S. are emerging as main beams of Chance Vought's Cutlass airplanes. Use of the big forgings marks a radical departure from previous methods of manufacture, and is expected to save Chance Vought hundred of dollars on each airplane.

Heretofore, scores of individually fabricated parts have been assembled and riveted together to build up main aircraft beams. The many operations required to build the beam were costly and time-consuming. The minute tolerances of the components of a built-up beam often accumulated to a discrepancy in the assembled beam. To simplify the beam, Chance Vought had experimented with a beam having only a few sections, joined by longitudinal capstrips, which proved to be subject to warpage.

Foreseeing the accuracy that would be required in high performance jet aircraft and the economy desired in post-war manufacture, Vought's production design engineers proposed that the main beam in its new Cutlass fighters be designed for machining from one large forging. Although a forging of the dimensions required never had been produced, the Wyman Gordon Company in Worcester, Mass. just had installed an 18,000 ton press which would accommodate it.

The main beam forgings, of 75ST aluminum alloy, are pressed from 120 in. long round bars 6½ in. in diameter. Two steel die blocks weighing 21,000 lb each form the forgings.

Delivered to the Chance Vought Aircraft plant in Dallas, Texas, the forgings are placed on a 36 by 168 inch Cincinnati Vertical Hydrotel machine equipped with tooling expressly designed to profile the main beam. While a hydraulically operated tracing unit moves around the outlines of a pattern of the beam, the big miller automatically performs 90 percent of the total machine operations on the beam in a fraction of the time formerly spent by machinists on the individual parts of a built-up beam. When the beam comes off the Hydrotel machine, only a few minor milling and boring operations remain.

BRITISH SCIENTISTS are puzzled over mysterious "radio signals" from space. The sounds produce a hissing sound and are visible in a cathode ray tube.

•

MANUAL OF DRAFTING STANDARDS for aluminum extrusions has been issued by the Extruded Products Division of the Aluminum Association. Purpose of the manual is "to outline certain basic practices that are necessary to extruded products and, for the first time, to standardize those practices as far as at this time seems practical."

•

UNIVERSITY OF TENNESSEE has started research and basic studies on metals that will add to the knowledge needed by scientists in harnessing atomic energy. The work will be undertaken by a research grant from the Atomic Energy Commission.

•

MOTION PICTURE CAMERA described as the world's fastest was unveiled at the Fifth National Instrument Conference. Capable of operating at a speed of 10,000,000 frames, or individual pictures, a second, the new camera is 1,000 times faster than any existing previously.

•

STANDARD NAMES FOR DUPLICATE PRINTS made by various processes will soon be announced by the International Association of Blue Print and Allied Industries to stop confusion of trade names. Most popular name is sought for each process.

•

AMERICAN STANDARD GEAR NOMENCLATURE, TERMS AND DEFINITIONS have been approved by American Standards Association. A committee representing manufacturers, users and independent experts prepared standards to give uniform terminology through industry.

•

MICA FLAKES are the secret of a three coat corrosion resistant paint developed by Westinghouse. A primer coat seals the surface and mica in second coat wards off moisture and oxygen. Third coat shuts out ultra-violet radiation.

•

AIR FORCE has distress device that tunes to an emergency channel and transmits SOS's and signals to allow ground equipment to fix position, all at the flip of a switch by pilot.

Helical Spring Nomograph

Tension or Compression

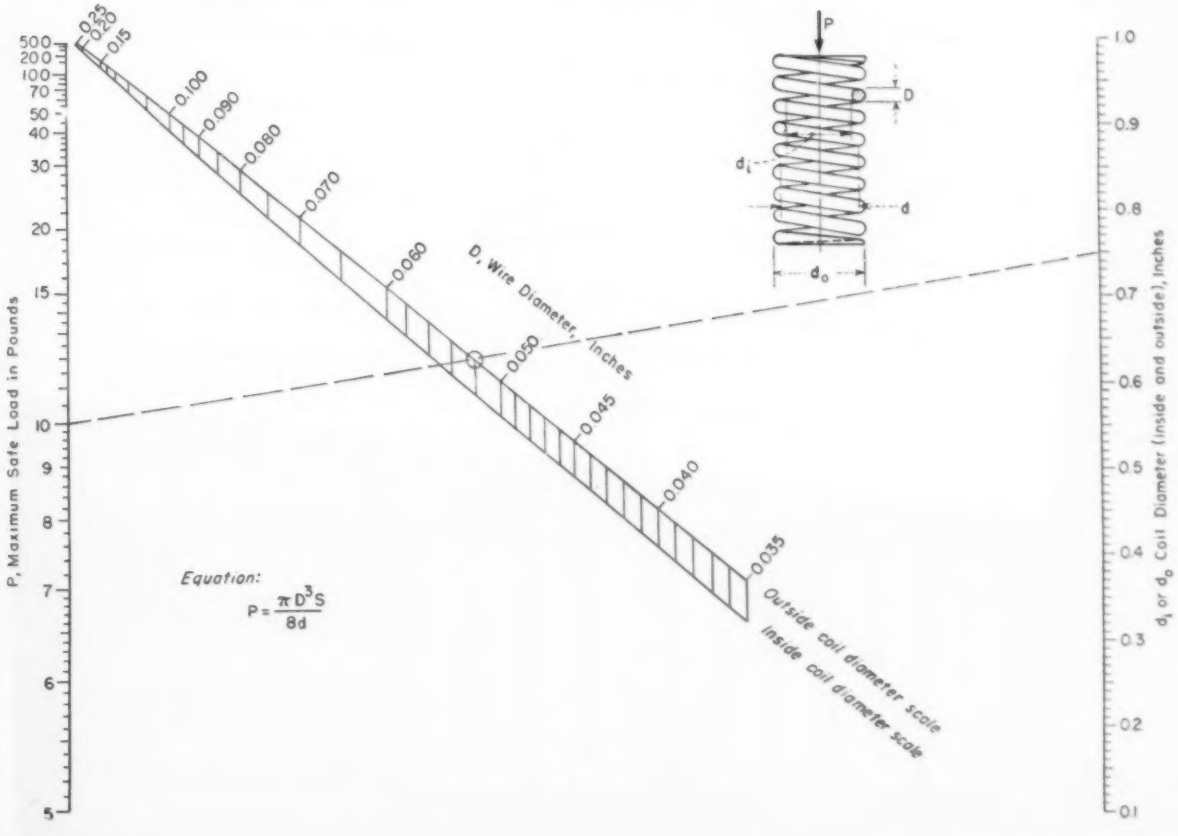
C. A. KULMANN

IN PROPORTIONING SPRINGS, designers are often confronted with space limitations: either the outside spring diameter is limited by a cylindrical bore into which it must fit, or the inside diameter is fixed by a pin or spindle. This chart has been prepared to simplify the calculation of small springs for such applications and utilizes the inside or outside coil diameter instead of the mean diameter.

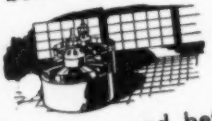
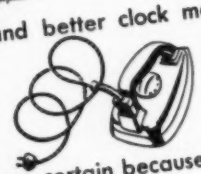
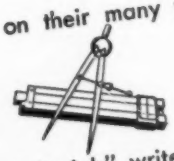
Based on the conventional formula, this nomograph takes into consideration an average of the variations in stress limits since the recommendations from many manufacturers differ. The allowable stress, S, (included in this chart) varies from 60,000 psi for the larger wire size (0.25 in.) to 120,000 psi for the smaller wire (0.035 in.). Neglected is the Wahl factor, K, which should be included for closely coiled springs; where the spring index, $c = d/D < 4$. In such a case, the factor $K = [4c-1)/(4c-4)] + 0.615/c$ would be used to modify the maximum safe load.

EXAMPLE: Find the wire size of a spring which is to fit into an 0.75 in. hole and must exert a 10 lb force. A single line drawn between the d_o and P scales establishes the wire size on the upper scale as 0.052 inches.

This chart is one of many which are included in the author's forthcoming McGraw-Hill book.



The right wire for the right job...

Technological advances in many industries constantly require new developments and new applications of wire and cable. A space-saving wire design has made possible smaller, more compact motors. A new and better form of heat resistance in turn prevents failure in generators.  Again, if a sharp turn can be given a wire, a new and better clock may be possible. New abrasion characteristics  may mean milady's iron won't fail. A city's safety is made more certain because a solenoid sets new records in performance. As simple a thing as better shielding in a wiring harness can be the secret of clearer radio and television reception. Auto-Lite Engineers, drawing on their many years of automotive experience, can answer such problems.  For more complete information on the "right wire for the right job" write on your company letterhead to

THE ELECTRIC AUTO-LITE COMPANY

Wire and Cable Division

Port Huron, Michigan • **Hazleton, Pennsylvania**

AUTO-LITE

die castings
plastics
wire and cable
industrial
thermometers

Natural Frequency and Efficiency of Vibration Mounts

CHARLES E. CREDE
Chief Engineer, The Barry Corp.

A SIMPLE WAY to minimize the disturbing effects of vibrations is by means of resilient mountings. Such mountings may have springs or rubber as the resilient element. As a rule, the most effective vibration mount is designed with its natural frequency as low as practically possible compared to the disturbing frequency. The natural frequency f_n (in cps) of a mounted system is: $f_n = \sqrt{K/m} \div 2\pi$ (for simple linear vibrations); where K is the spring rate, lb/in.; $m = W/g$ which is the supported mass, lb sec^2/in. When the spring rate is linear: $f_n = 3.13\sqrt{1/d}$; where d is the static deflection in inches of the mount under the weight of the supported body. This is plotted in the graph below.

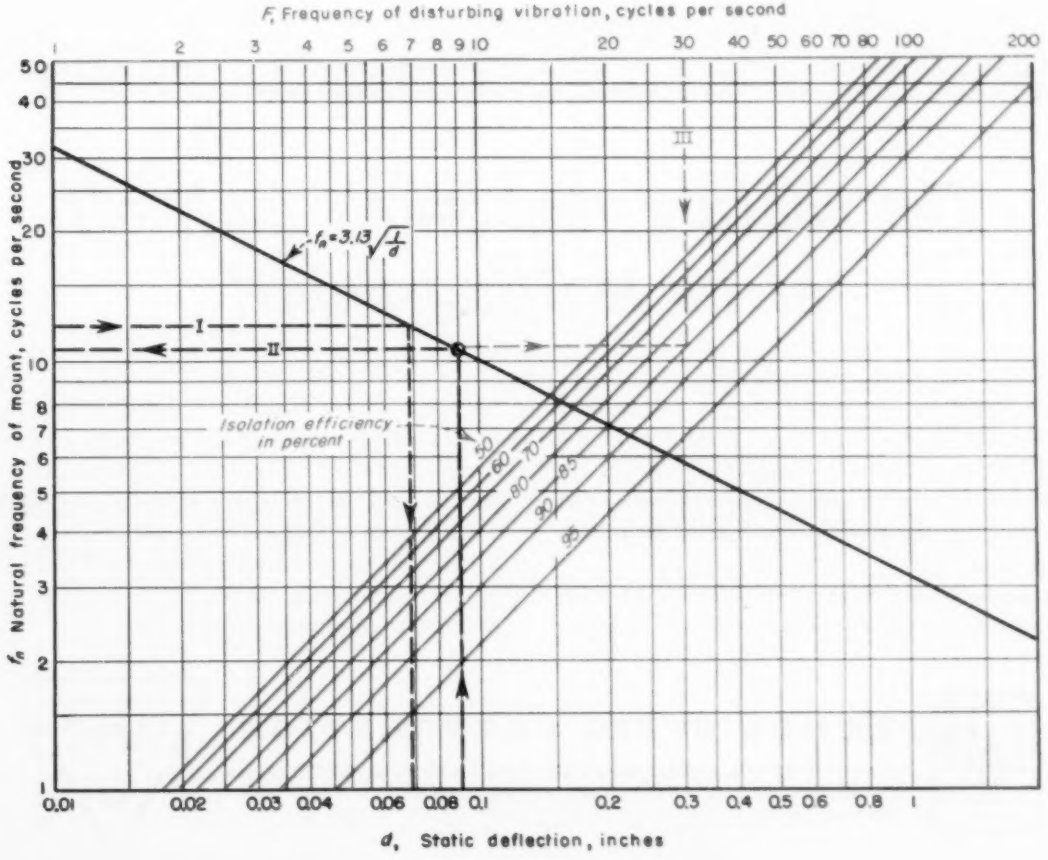
In addition, this chart is arranged to indicate the effectiveness of a vibration mount. For maximum effectiveness, the frequency ratio $R = F/f_n$ should be as high as practically possible; where F is the disturbing frequency. From a practical standpoint, this ratio should not be less than 2.5. Transmissibility, $T = 1/(R^2 - 1)$, is a measure of the vibration transmitted by the mount. Isolation efficiency, $E = 1 - T$, is a measure of the vibration isolated by the mount. When $R = 2.5$, $T = 0.19$ and $E = 0.81$; i.e., 81 percent of the vibration is isolated. From a physical standpoint, isolation efficiency refers either to a reduction of force or a reduction of vibration amplitude: $E = (P - p)/P$, where P is a force created within the mounted body and p is the portion of this force transmitted to the support. Where the support vibrates with an amplitude A and the amplitude of the mounted body is a, isolation efficiency is: $E = (A - a)/A$.

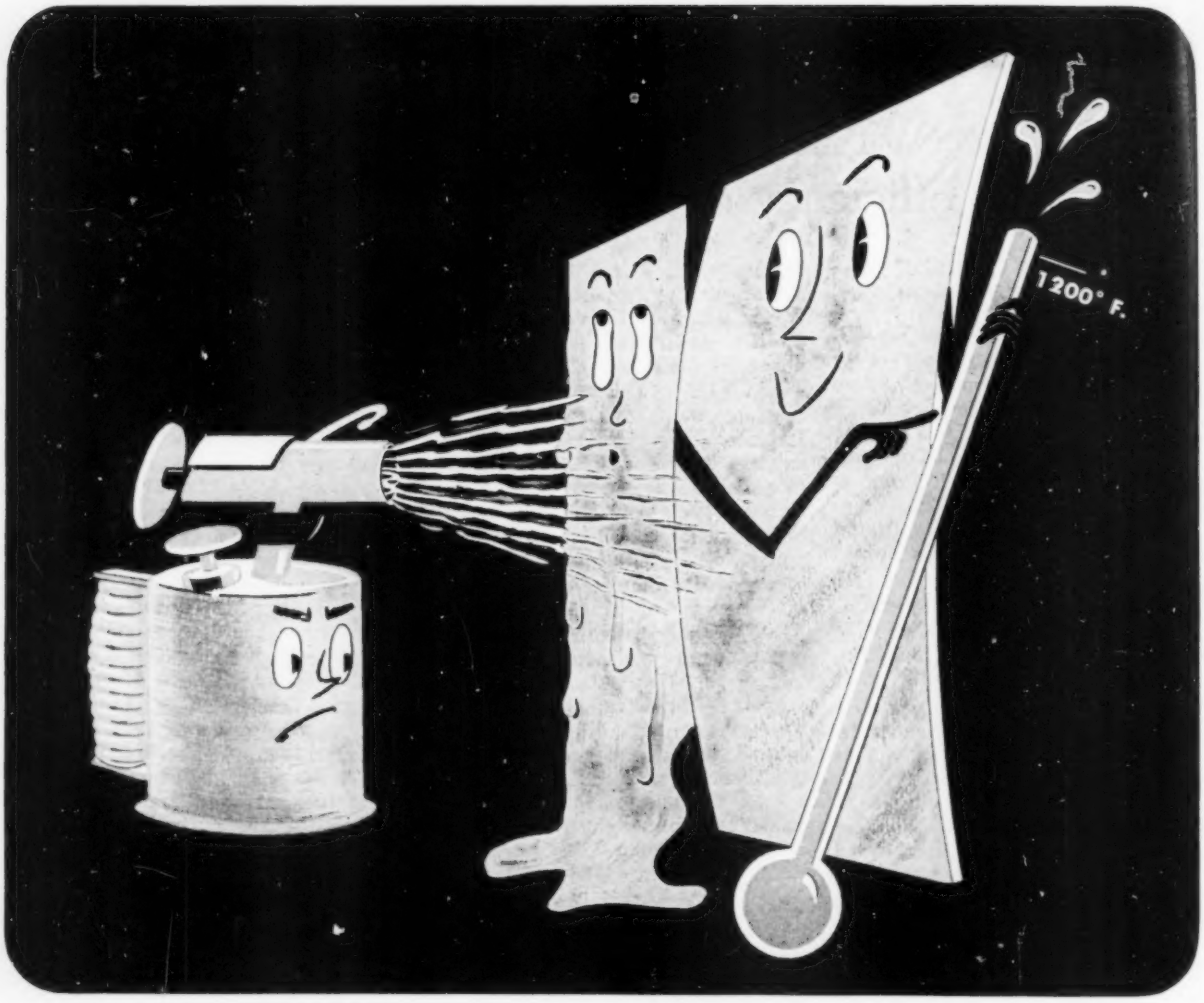
EXAMPLE: The weight of a 60 lb reciprocating machine is to be equally shared by four mounts. This machine operates at a speed of $F = 1{,}800$ rpm (30 cps); the problem is to choose a mount and find its effectiveness.

Since the ratio R should not be less than 2.5: $f_n \leq 30/2.5$ or 12 cps. Using the graph, line I gives a minimum deflection of 0.07 in. Thus, the required spring rate can be calculated: $K = W/4 \div d = 15/0.07 = 214$ lb per in. With this, a spring can be designed or a commercial mount chosen.

Having decided upon a mount that will deflect 0.09 in. (under a 15 lb load), the natural frequency would be found to be about 11 cps (line II). The efficiency of this mount is determined from line III to be 85 percent.

In cases where the weight is not evenly distributed among the individual mounts, stiffnesses should be chosen so that the static deflection of each mount is equal under the supported weight. Thus the supported body will have simple translational motion.


F, Frequency of disturbing vibration, cycles per second
1 2 3 4 5 6 7 8 9 10 20 30 40 50 60 70 80 100 200
50 40 30 20 10 8 7 6 5 4 3 2 1
fn Natural frequency of mount, cycles per second
fn = 3.13 √(1/d)
I
II
III
Isolation efficiency in percent
50 60 70 80 85 90 95
0.01 0.02 0.03 0.04 0.06 0.08 0.1 0.2 0.3 0.4 0.5 0.6 0.8 1
d, Static deflection, inches



The coating that won't melt off at its melting point!

That's the story of the aluminum coating on heat-resistant Armco ALUMINIZED Steel.

The melting point of aluminum is about 1200° F., but when steel is hot-dip coated with aluminum to form Armco ALUMINIZED Steel, the coating doesn't melt off at even higher temperatures!

The reason is that an iron-aluminum alloy starts to form above 900°. This serves as a refractory layer at higher temperatures. The aluminum supplies resistance to heat by its conversion to an alloy; the steel core provides the strength necessary for products subjected to high temperature service. This gives your products good resistance to a *combination* of heat and corrosion.

Heat reflectivity is excellent up to 900° F. About 80% of the radiant heat sent against the surface of Armco ALUMINIZED Steel *bounces back.*

50th ANNIVERSARY SPECIAL PURPOSE STEELS

ARMCO STEEL CORPORATION

6060 CURTIS STREET, MIDDLETOWN, OHIO. PLANTS AND SALES OFFICES FROM COAST TO COAST. THE ARMCO INTERNATIONAL CORPORATION, WORLD-WIDE

ARMCO

Standard Dimensional Tolerances

Westinghouse Electric Corp.

THIS TOLERANCE STANDARD can save a considerable amount of time for the designer and draftsmen. For if the manufacturing and engineering departments can agree on such tolerances as these, it becomes unnecessary to specify them on each drawing. However, there will be instances where these limits are not adequate, then specific tolerances will be required. In all cases, this standard will apply when a dimension does not show a tolerance.

DIMENSIONS BETWEEN MACHINED SURFACES

(except diameters)

Basic Dimension	Rough Machining*	Finish Machining**
Up to 1/4 Incl	±0.005	±0.003
Over 1/4 to 1/2 Incl	±0.008	±0.004
Over 1/2 to 1 Incl	±0.010	±0.005
Over 1 to 6 Incl	±0.015	±0.006
Over 6 to 12 Incl	±0.025	±0.008
Over 12 to 24 Incl	±0.031	±0.010
Over 24	±0.063	±0.015

The shops will be governed by the "finish machining" tolerance unless the drawing specifies "rough machining".

* "Rough Machining" means shaping to approximate dimensions with a cutting tool.

** "Finish Machining" means Finish Machining to dimensions indicated. Shape to dimensions with a cutting tool; the accuracy of the surface to be such as good shop practice requires, but not to have anything done upon it for mere appearance.

TURNING AND BORING

	Outside Diameter		Inside Diameter	
Basic Diameter	Rough Turn	Fin. Turn	Rough Bore	Fin. Bore
Up to 1/4 Incl	±0.005	+0 to −0.004	±0.005	−0 to +0.004
Over 1/4 to 1/2 Incl	±0.008	+0 to −0.005	±0.008	−0 to +0.005
Over 1/2 to 6 Incl	±0.010	+0 to −0.006	±0.010	−0 to +0.006
Over 6 to 12 Incl	±0.025	+0 to −0.008	±0.025	−0 to +0.008
Over 12 to 24 Incl	±0.031	+0 to −0.010	±0.031	−0 to +0.010
Over 24	±0.063	+0 to −0.015	±0.063	−0 to +0.015

The shops will be governed by the "finish turn" or "finish bore" tolerances, unless the drawing specifies "rough turn" or "rough bore". Total run out for finish turn must not exceed .002 for eccentricity.

Total run out means the total difference between the highest and lowest reading of the dial indicator.

PUNCHED HOLES

Diameter −0.0035 to +0.0085 for material 1/16 thick or less and holes of 10 inches diameter maximum.

SHEARING TOLERANCES — STEEL ANGLES

Leg Thickness	Tolerances
Up to 1/4 Incl	±1/16
Over 1/4 to 3/4 Incl	±1/8

Beams and channels are either sawed or burned.

DIMENSIONS BETWEEN CENTERS OF HOLES

Dimension Between Centers	Tolerances
Up to 24 Incl	±1/64
Over 24	±1/32

DRILLED HOLES

Diameter	Tolerances
Up to 1/8 Incl	−0.00 to +0.003
Over 1/8 to 1/4 Incl	−0.00 to +0.006
Over 1/4 to 1/2 Incl	−0.00 to +0.010
Over 1/2 to 1 Incl	−0.00 to +0.012
Over 1 to 4 Incl	−0.00 to +0.015

Tolerances do not apply to tap drills.

FINISH GRINDING

Specify tolerances on drawing. Total run out must not exceed .0004.

FLAME CUTTING TOLERANCES

Plate Thickness	Tolerances
Up to 1/2 Incl	±1/16
Over 1/2 to 1-1/8 Incl	±3/32
Over 1-1/8 to 3 Incl	±1/8
Over 3 to 5 Incl	±5/32
Over 5 to 6 Incl	±3/16

MACHINE REAMED HOLES

Diameter	Tolerances
Up to 1/2 Incl	−0.00 to +0.0005
Over 1/2 to 1-1/4 Incl	−0.00 to +0.0010
Over 1-1/4 to 2 Incl	−0.00 to +0.0015

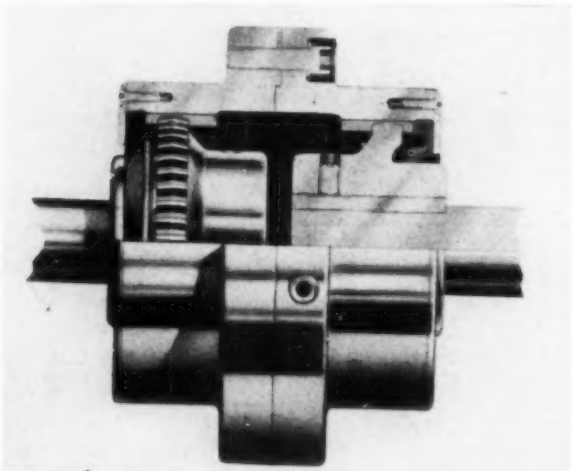
SHEARING TOLERANCES — SHEET AND PLATE

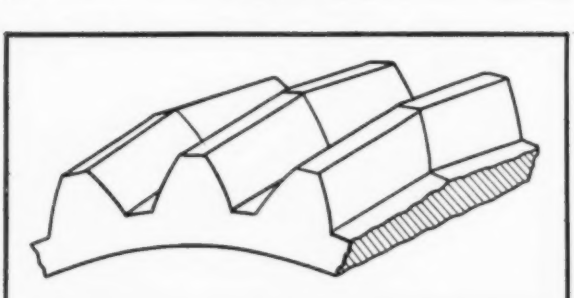
Thickness	Tolerances
Up to 1/8 Incl	±1/32
Over 1/8 to 5/16 Incl	±1/16
Over 5/16 to 3/4 Incl	±3/32
Over 3/4 to 1	±1/8

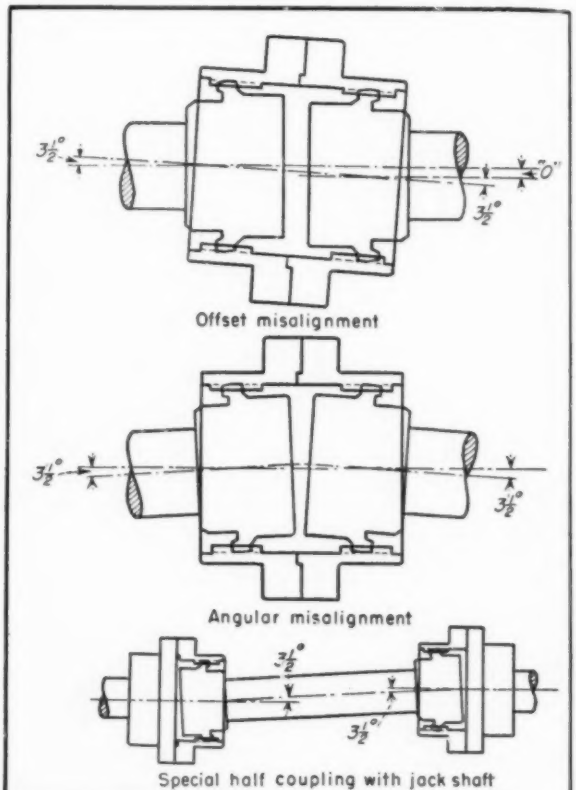
The size of sheet or plate shall be measured along the top surface, that is the surface that the blade of the shear enters.

These tolerances are also to be used for out of squareness.

NEW COMPONENTS







Dihedral Tooth Makes Coupling More Flexible

A dihedral angle is one which is formed by two intersecting planes. This has been incorporated in the tooth shape of a spline or gear type flexible coupling. As a consequence of this chamfering of the gear teeth, angular and offset misalignment between shafts up to seven degrees can be handled. Moreover, the clearance and backlash necessary to permit movement of the straight tooth type is unnecessary, or nearly so, for the dihedral tooth. Finally, the bearing area is never less than that of half the tooth and this occurs only at maximum misalignment. Because of this the oil film does not tend to rupture. Additional features are oil seals to keep lubrication in and dirt out and free end float which permits electrical machinery to find its magnetic center and prevents strain on thrust bearings.

The use of flexible couplings to save time lining up equipment, to simplify machine design by eliminating the necessity for precision alignment of shafts and to eliminate alignment problems caused by such conditions as settling foundations can be more widespread, it is claimed, now that this coupling is available.

The selection of the proper size coupling is dependent on two factors. It must be large enough to accommodate the larger of the two shafts to be connected. It must be adequate to carry the load and have long life. To achieve the latter condition, it is common practice to multiply the load to be carried by a service factor. The coupling whose capacity is equal to this amplified load can be selected with the assurance that it will perform its task adequately.

In regard to the dihedral coupling it is felt by the manufacturer that for compressors, internal combustion engines, dredge pumps, pulverizers and other heavy duty applications where a load or vibrating mechanism is subject to a pulsating or heavily vibrating effect, a service factor of three should be ample. On diesel engines in which there is an actual reversal of torque, a service factor of five is not too much. Steam turbines, on the other hand, usually offer no difficulty as regards torque capacity, and a service factor of one is generally sufficient.

Sizes of this coupling range from 1⅜ in. to 5 in. bore and capacities from 12 to 350 hp at 100 rpm. Special models can be manufactured to handle misalignment up to 12 degrees between shafts. For applications where outside diameters must be held to a minimum, there are special flangeless or sleeve type couplings.

Ajax Flexible Coupling Co., Inc., Westfield, N. J.

Circle No. 1 on Reader Service Card

Diaphragm Control Valve Embodies Steel Open Yoke

A cast steel "open yoke" with accessibility formerly obtainable only in an iron casting is a feature of this valve. The advantage is an increase in strength and resistance to shock that is found in steel.

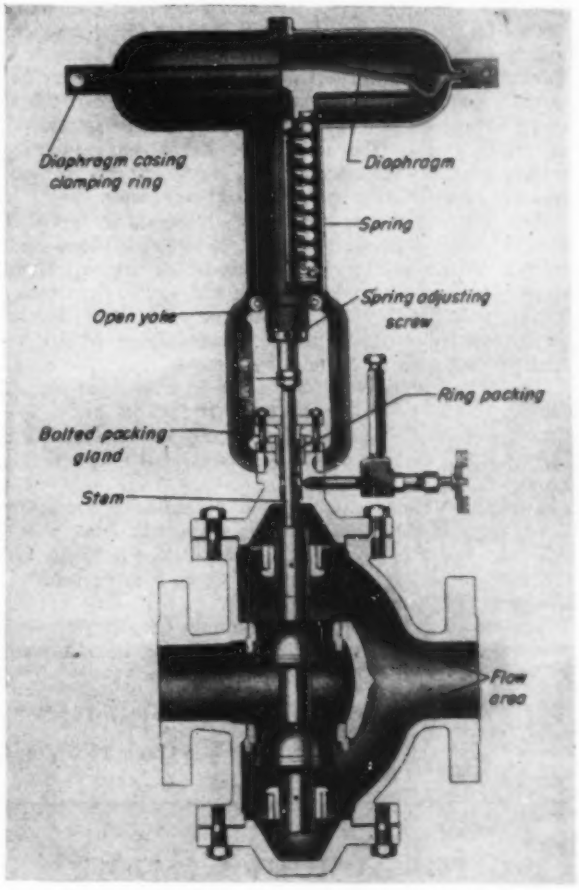
This yoke, incorporated in the diaphragm motor of the valve, permits accessibility to the stuffing box and the spring adjusting screw of the motor. One of the features of the motor is the spring barrel made of welded, corrosion-resistant, nickel-copper-alloy steel tubing. Another is the boltless casing assembly constructed with a clamping ring which permits ready inspection and reassembly. The diaphragms are made of neoprene with fabric reinforcements.

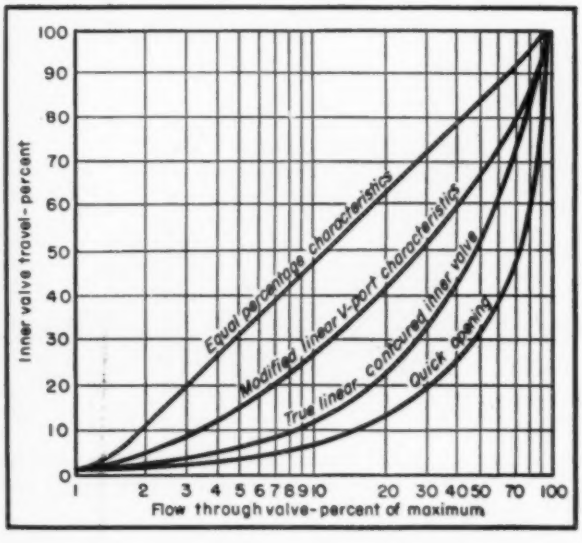
The bolted gland stuffing box is used in sizes above 4 in. Below this size the screw gland stuffing box is standard. The molded ring packing is made of graphited asbestos.

The valve body has flow passages with a minimum average area of 140 percent of comparable size pipe. Pressure ratings go up to 1,500 lb and temperature to 1,000 F. The inner valve open free areas average 80 percent of pipe area permitting pressure drop to take place principally through the inner valve.

Inner valves are available in a number of materials from 316 stainless steel through nitrided or Stellite-faced stainless steels to soft seat disk inserts of Teflon or Hycar. Single and double seated inner valves are supplied in full nominal body sizes or with reduced trim down to one-half of the nominal body size. The graph shows the characteristics of the available standard inner valves.

Kieley & Mueller, 2033—43rd St., North Bergen, N. J.




Inner valve travel - percent
Flow through valve - percent of maximum
Equal percentage characteristics
Modified linear V-port characteristics
True linear contoured inner valve
Quick opening

Valve Size, In.	Percentage V-Port or Contoured Inner Valves		Quick Opening Inner Valves	
	Valve Travel, In.	Effective Diaphragm Area, Sq. In.	Valve Travel, In.	Effective Diaphragm Area, Sq. In.
1/2–3/4	15/32	28	3/8	28
1, 1 1/4	11/16	65	3/8	28
1 1/2	15/16	65	1/2	65
2	1 1/16	95	5/8	65
2 1/2	1 3/16	95	3/4	95
3	1 3/8	95	7/8	95
4	1 3/4	95	1 1/8	95
5	1 7/8	95	1 3/8	95
6	2 1/4	140	1 5/8	140
8	2 1/2	140	1 3/4	140
10	3	300	2 3/8	300
12	3 1/2	300	2 1/2	300
16	3 1/2	300	3 1/2	300

Circle No. 2 on Reader Service Card

CONTINUED ON PAGE 172

Phase Meter Measures Phase Shifts to 1/10 Degree

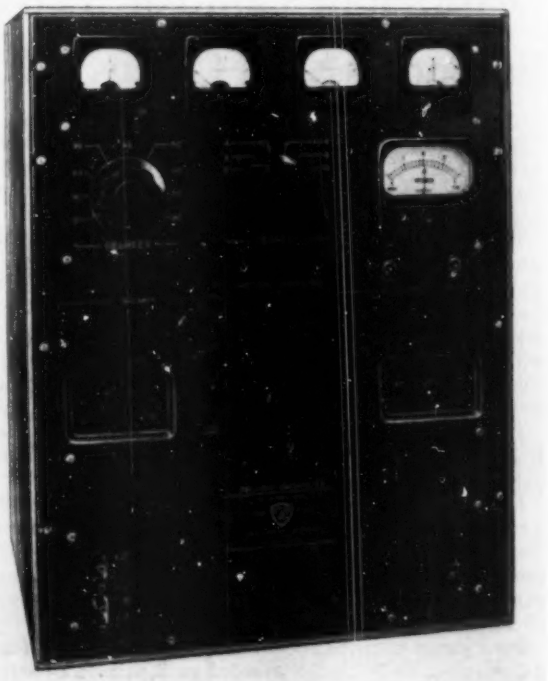
Originated as an aid to design of single-sideband transmitters by the U. S. Air Force, this phase meter provides means for precise determination of phase relationships throughout the audio spectrum of 30 to 20,000 cycles per second. Its accuracy and ease of operation make it useful in all investigations requiring many precise measurements of phase angle. The instrument has a self-calibrating feature whereby the operator can check accuracy without recourse to calibrating apparatus and techniques.

This instrument measures phase difference in terms of the calibrated phase shift required to establish phase coincidence of the voltages in the measuring circuit. Phase angle is read from two decade dials and a zero-center meter having a full-scale range of plus or minus one degree. Switch-selected controls permit determination of lag or lead and of positive or negative "sense."

The phase meter is self-contained in a shielded walnut cabinet 19½ in. wide, 16¼ in. deep, and 25 in. high. The chassis and panel are of aluminum and are so constructed that they will fit a standard 19 in. relay rack. The instrument weighs 110 lb.

The phase meter controls, the indicating instruments, the fuses, and the input terminals are on the front panel. All controls are identified. The controls that normally are not used in the measurement are recessed to prevent accidental change in their settings.

The power supply for the electron-tube circuits is integral with the instrument chassis. It is designed to operate from an unregulated, 105/125 v, 60 cycle circuit.



W. L. Maxson Corp., 460 W. 34th St., New York 1, N. Y.

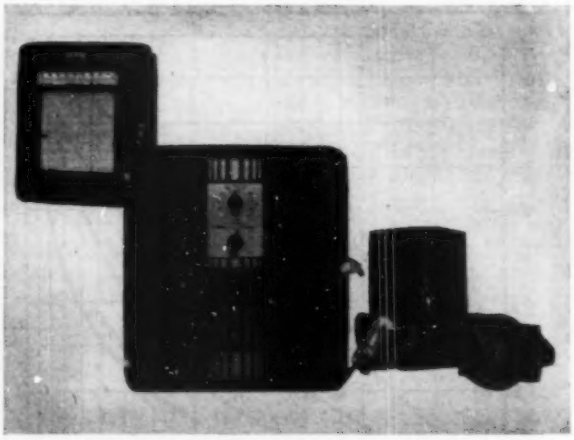
Circle No. 3 on Reader Service Card

Control System Responds to Rate of Change of Variable

The purpose of a control system is to react to a variation in the controlled process and to bring it back into line. Usually, a control system goes into action by steps as the variation in the controlled process increases. The control system shown here, however, varies according to the speed with which the controlled variable changes. If furnace temperature, for example, begins to fall, the control system immediately opens the fuel valve. The faster the temperature drops, the wider the valve is open. Then as the rate of temperature departure decreases, the valve closes in proportion until the temperature is back to its original position.

A thorough study of the preceding model and of its applications was made before development began on the present unit. Like the previous model, this one also has proportional and reset control actions, and is applicable to the regulation of temperature, pH, chemical concentration and gas analysis. A recording instrument is linked to the electric valve drive mechanism. Existing installations using the earlier model can be converted.

Offering greater sensitivity than its predecessor, the unit has no moving parts; control action is accomplished by electronic circuits. Valve position can be measured remotely at the control panel without interfering with control action. Major electronic components are plug-in, replaceable types. The control chassis comes out as a unit for inspection.



Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa.

Circle No. 4 on Reader Service Card

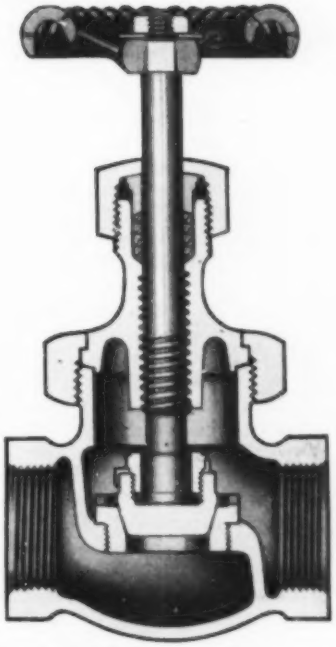
CONTINUED ON PAGE 174

The easy way to specify piping is to specify piping from CRANE

That's because Crane manufactures the world's most complete line of quality valves, fittings, pipe and accessories. This vast assortment of equipment is carefully arranged—in one catalog—for your quick selection. Whether you're designing an *Oil Filter,* as shown here, or something more simple . . . or complex . . . you'll find all the piping materials you need in the Crane Catalog.

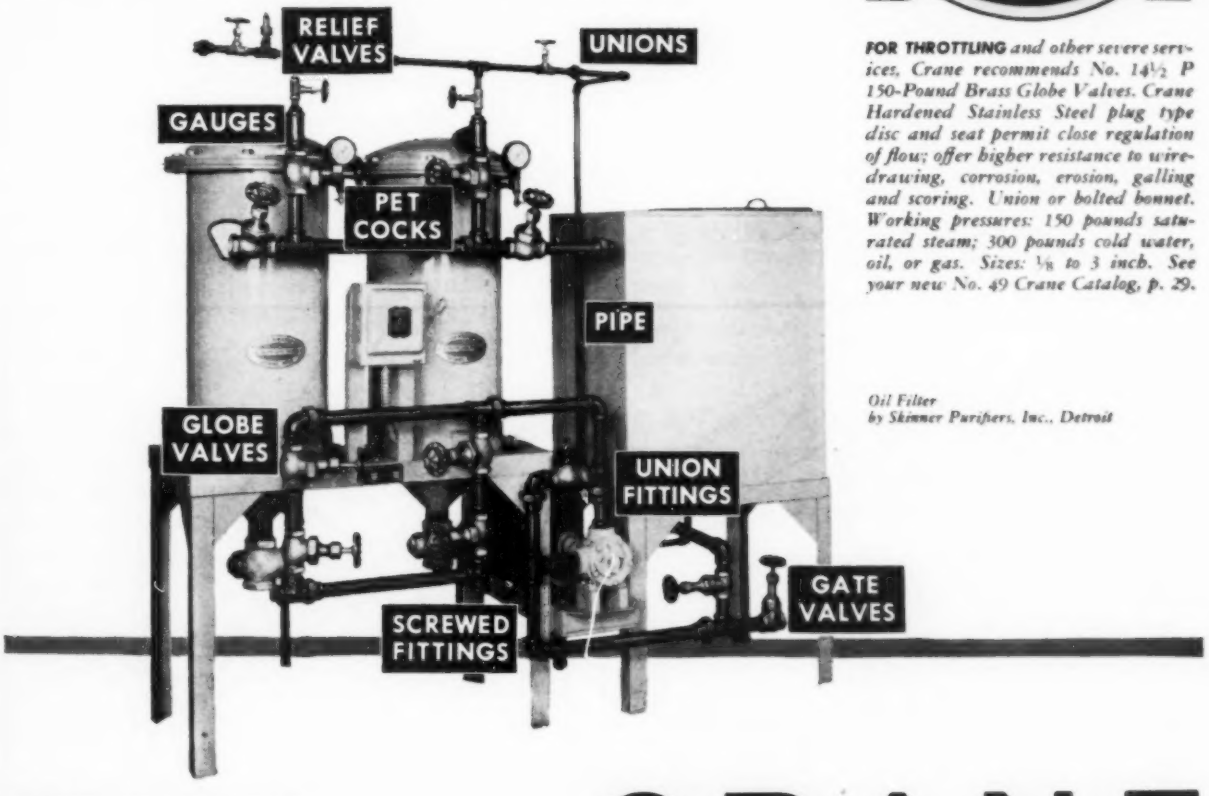
All other piping procedures are simplified, too, when you rely on Crane. Final product assembly work is smoother . . . buying and storekeeping become easier. And, above all, your product acquires added value because it is Crane equipped. Buyers know from experience that Crane Quality in piping equipment has never been surpassed.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas



FOR THROTTLING *and other severe services, Crane recommends No. 14½ P 150-Pound Brass Globe Valves. Crane Hardened Stainless Steel plug type disc and seat permit close regulation of flow; offer higher resistance to wire-drawing, corrosion, erosion, galling and scoring. Union or bolted bonnet. Working pressures: 150 pounds saturated steam; 300 pounds cold water, oil, or gas. Sizes: ⅛ to 3 inch. See your new No. 49 Crane Catalog, p. 29.*

FOR COMPLETE SELECTION . . . BETTER PIPING LOOK ALWAYS TO THE BROAD CRANE LINE



Oil Filter by Skinner Purifiers, Inc., Detroit

EVERYTHING FOR EVERY PIPING SYSTEM **CRANE**

VALVES • FITTINGS • PIPE • PLUMBING AND HEATING

Lockwasher Joined to Nut Is Free to Rotate

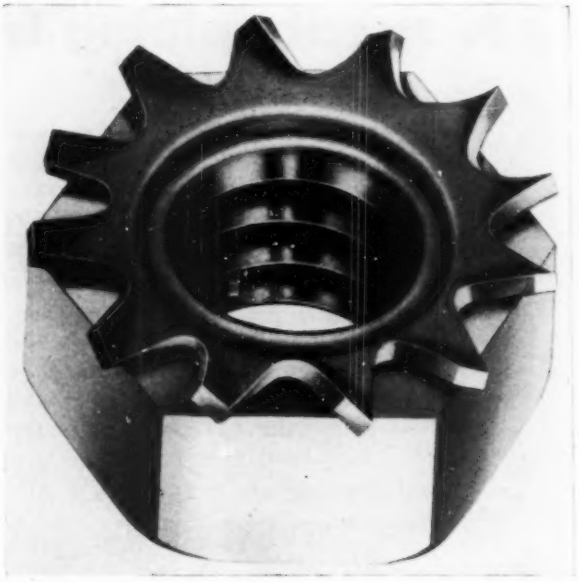
A lockwasher and a nut have been pre-assembled to form an integral unit which retains the characteristics of each component but can be handled in an assembly operation as a single part. This fastening has been designed so that the lockwasher, although free to rotate with respect to the nut, cannot drop off.

These fastenings are available in two types to meet standard nut requirements. In one, the nut conforms with the American Standard Light Nut Series, and in the other it conforms with the American Standard Machine Screw Nut and Regular Nut Series. The assembled lockwasher is of the external tooth type and is designed to have greater ultimate strength than a separate lockwasher of equivalent size. Because the lockwashers are positioned with respect to the nut, greater locking power is possible than with separate nut and lockwasher. Furthermore, the lockwasher hole tends to pilot the nut into the bolt and makes starting easy.

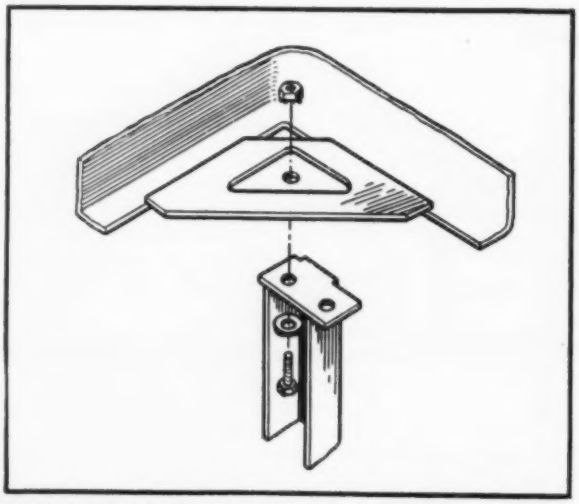
The manufacturer points out that there are a number of advantages to be secured if this product is used. First, since there is only one unit to handle, the separate lockwasher assembly operation can be eliminated. Second, lockwashers cannot be lost. Third, the free spinning aspect of the pre-assembled lockwasher should increase the speed of assembly. Fourth, the possibility of using a lockwasher which is too large is overcome by these pre-assembled units.

In addition to emphasizing the inherent advantages of this product, the manufacturer points out that the use of these fastenings will reduce production delays; that their use will simplify paper work; and that their use will simplify and make less costly control procedures.

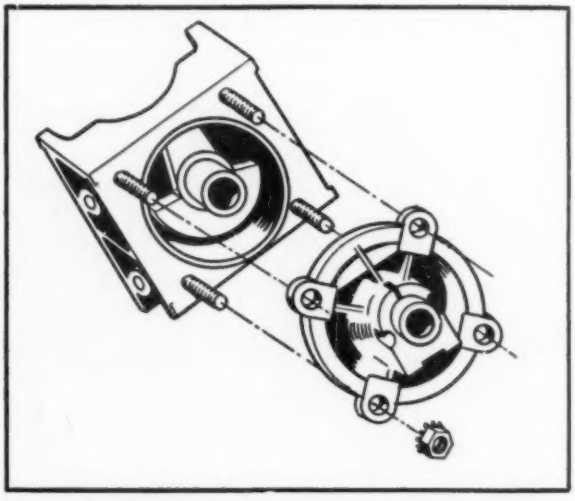
Shakeproof Inc., 2501 N. Keeler Ave., Chicago 39, Ill.



Diameter	6	8	10	10	1/4	1/4
Thread	32	32	24	32	20	28
Across Flats	5/16	11/32	3/8	3/8	7/16	7/16
Across Corners	.344	.378	.413	.413	.482	.482
Thread Length	7/64	1/8	1/8	1/8	3/16	3/16
Nut Thickness	7/64	1/8	1/8	1/8	3/16	3/16
Height	9/64	5/32	5/32	5/32	15/64	15/64
Washer OD	11/32	3/8	13/32	13/32	1/2	1/2



THE TOP OF A GAS RANGE is secured to an upright brace by means of the integral nut and lockwasher unit. Elimination of one operation reduces assembly time on the production line.



IN AN OUTBOARD MOTOR, the die cast crankshaft bearing housing passes over the crankcase studs. The fastening completes assembly in one operation and provides greater locking power.

Circle No. 5 on Reader Service Card

CONTINUED ON PAGE 176

Mr. Parks had a tubing problem . . .

so he called in the ELECTRUNITE Metallurgist . . .

and in practically no time at all . . .

Mr. Parks manufactures school desks. Very good desks, too . . . but, even so, Mr. Parks is always looking for ways to make them better.

This is the way Mr. Parks' problem came about . . . 1½" x 11 gauge tubing is bent U shape to form a support for both seat and table of Mr. Parks' desks. Design calls for a short radius bend, and he was using a fully normalized tube that Rockwell "B" tested under 55.

"Not stiff enough", decided Mr. Parks. "No desk of mine is going to sag when a heavyweight leans against it! On the other hand, the tube must not be so hard it breaks in bending." What to do? — one thing, of course, and Mr. Parks did it. He called in the ELECTRUNITE Tubing Metallurgist. As a result of this call, processing changes were made resulting in a stiffer tube with a higher yield point and a higher Rockwell reading. These tubes readily take the short radius bend and still give Mr. Parks' desks the extra sturdiness and strength he wanted them to have.

Mr. Parks isn't his real name, of course, but his problem was real. When you have a tubing problem, why not do as Mr. Parks did? Call for a Republic ELECTRUNITE Tubing Metallurgist. There is no charge for his services and no obligation on your part for his help. Just let us know when you would like to see him—and he'll be there.

REPUBLIC STEEL CORPORATION
STEEL AND TUBES DIVISION • CLEVELAND 8, OHIO
Export Department: Chrysler Building, New York 17, New York

Republic
REPUBLIC STEEL
ELECTRUNITE TUBING

Phototube Improves Nuclear Scintillation Counter

Nearly five times as sensitive as the original tube introduced about a year ago, an improved head-on multiplier phototube is one of a group of phototubes which have made possible the design of new scintillation counters, basic instruments of nuclear research, which are rapidly replacing the Geiger counter in many applications for the detection and measurement of atomic and nuclear radiation. Other applications involve low-level, large-area light sources. Other features are greater cathode-collection efficiency, higher current amplification and shorter overall length.

The spectral response of the tube covers the range from about 3,000 to 6,400 angstroms. The tube, therefore, has high sensitivity to blue-rich light and negligible sensitivity to red radiation. Because of its spectral response, the tube is well suited for use with organic phosphors such as anthracene, as well as with inorganic materials such as silver-activated sinc sulfide.

The phototube utilizes a "head-on" construction with a photo-cathode measuring 1½ in. in diameter on the inner glass surface of the face end of the bulb. The size of the cathode area permits efficient collection of light from large-area light sources and permits the design of a scintillation counter which can respond to a broad area for radioactivity. The large, essentially flat cathode area permits good optical coupling between excited phosphor and the cathode. As a result, scintillation pulses are larger in amplitude than the majority of the accompanying dark-current pulses. In this way, discrimination against the interference of dark-current impulses is facilitated.

Radio Corp. of America, Camden, N. J.

Circle No. 6 on Reader Service Card

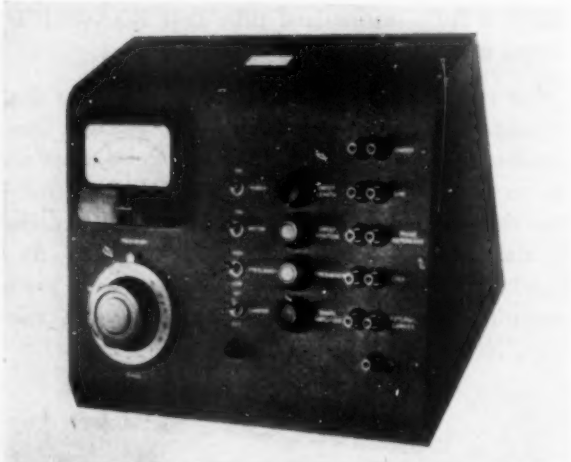
Dynamic Analyzer is Easily Modified

A dynamic analyzer facilitates the measurement of frequency and transient response of low frequency systems by electrical methods. It is applicable to the servomechanism, either as a closed loop, or in its individual components.

The instrument functions by providing periodic signals to be injected into the error or input channels of the device under test, together with sweep and comparison voltages with which to view the output member excursion on the cathode ray oscilloscope. These waveshapes are generated by electro-mechanical elements geared together and driven by a precision speed control.

Of chief interest is the flexibility of the device. The signal generating mechanics are mounted on a separate shock-mounted horizontal chassis, which is accessible through panel cutouts in the case. The elements themselves are mounted with breadboard apparatus. A vertically mounted electronic chassis furnishes the power for the speed drive and the excitation voltages. This construction allows the user to quickly modify the unit for some special test, by changing gear ratios and by adding signal generating components.

The range of modulating frequencies is from 0.1 to 50 cps for transfer function tests. Phase measurements can be made with accuracies of plus or minus 2 deg. For the transient tests, the damped natural frequency and the height of the first overshoot can be measured.



Industrial Control Company, 1462 Undercliff Ave., New York 52, N. Y.

Circle No. 7 on Reader Service Card

CONTINUED ON PAGE 178

Time and Cost Saving Features

TYPE "A" ASSEMBLY BIT

ON WHICH CLUTCH HEAD CHALLENGES COMPARISON WITH ANY AND ALL OTHER SCREWS

1. ***What Other Screw*** equals the high visibility of the CLUTCH HEAD recess to check out the slow-down of hesitation . . . even with "green" operators?
2. ***What Other Screw*** frees the line from burred and chewed-up heads with automatic straight driving . . . with Center Pivot entry that prevents driver canting?
3. ***What Other Screw*** has a non-tapered driving engagement (without dangerous "ride-out" as set up by tapered driving) to eliminate the hazard of skid damage? . . . and the need for fatiguing end pressure?
4. ***What Other Screw*** provides a simple Lock-On which unites screw and bit as a unit to hurdle "fumble spots" by permitting one-handed reaching and driving from any angle?
5. ***What Other Driver*** can begin to approach the durability record of the rugged Type "A" Bit . . . 214,000 screws driven non-stop?
6. ***What Other Assembly Bit*** can be *repeatedly* reconditioned on the spot by a 60-second application of the end surface to a grinding wheel . . . for unmatched tool economy.
7. ***What Other Modern Screw*** has a recess basically designed for operation with a common screwdriver . . . for the simplification of field service adjustments?

COMMON SCREWDRIVER

According to users of CLUTCH HEAD *Screws, you may confidently expect these time- and cost-saving features to deliver assembly production increases ranging from 15% to 50%.*

CLUTCH HEAD SCREWS

The New CLUTCH HEAD *Brochure details and illustrates the exclusive advantages of America's Most Modern Screw. Your copy will come to you by mail on request . . . mentioning the types and sizes of screws in which you are interested.*

UNITED SCREW AND BOLT CORPORATION

CLEVELAND 2 CHICAGO 8 NEW YORK 7

Images Are Projected on Drawing Board for Copying

A vertical projector has been built for use by artists and draftsmen which throws the image of a physical object, photograph, blueprint, or drawing on the drawing board where it may be copied directly.

The physical object, drawing, photograph or blueprint is positioned as shown, and its image is reflected by a mirror placed inside the housing through a 12 in. lens to the drawing board below. There is one control to bring the image into focus and another which raises or lowers the housing to enlarge the image up to four times the size of the object or to reduce it to about one-fourth the size.

The projector, which is 9 ft high, is installed directly over the drawing board making use of the dead overhead space usually available. The clip for holding copy can be extended to a height of 20 in. and the copy board slides out for oversize copy or maximum reduction. The housing is counterbalanced to decrease the force needed to raise it. For most jobs, slight dimming of room light is necessary. For extreme enlargements, moderate darkening is required.

The projector has a number of features which may be mentioned. The first is a motor driven exhaust fan which maintains the temperature of the light housing at a uniform low level. Another is the group of four photo-enlarging bulbs and their reflectors which cover the surface of the copy or object with strong, even light. Third is the bellows which is similar to that used by studio cameras. Last is the compound, 12 in., 4.5 lens which gives a bright, sharp image for either reduction or enlargement.

The projector will speed up and improve production of artwork for instruction manuals, parts catalogs, specifications, technical manuals, and advertising and promotional literature, according to the manufacturer.

J. A. Engel, Inc., 624 Syndicate Bldg., Minneapolis, Minn.

THE OPERATION OF THE MACHINE involves these functions: (A) Photographs, blueprints, drawings to be projected are clipped on here. (B) Physical objects to be projected are placed here. (C) Image is projected on the drawing board. (D) Control is used to bring the image into focus. (E) Control is used to raise or lower the housing for enlarging or reducing.

Circle No. 8 on Reader Service Card

Riser Compound Simplifies Casting

Basically a mixture of aluminum and iron oxide, this exothermic riser compound, when ignited, produces a quantity of pure iron and alumina slag and generates heat at a temperature of more than 4,000 F. In practice, the riser compound already weighed out into proper amounts placed in paper bags is thrown on the riser just before a skin has formed over its entire top surface. The compound ignites, the exothermic reaction occurs, and the heat evolved reheats the metal in the riser and the surrounding sand. The partially superheated iron produced by the reaction feeds the shrinkage of the casting. The fluid slag produced by the reaction comes to the surface where it acts as a hot insulating blanket and yet remains plastic so that atmospheric pressure can depress it and follow up the feeding.

The use of this riser compound is claimed to have a number of advantages. First, the riser metal and the metal in the casting directly under the riser being hotter than the rest of the casting causes the freezing of the casting to progress gradually from the sections most remote from the riser toward the risers. This insures casting soundness without the use of chills. Second, since the fluid feed metal is desired near the casting surface, where the riser compound will be able to heat the metal, risers need be filled to only one-third the normal volume. This will reduce the amount of foundry metal required, reduce the amount of sand and molding labor needed, or conversely increase the foundry capacity. Third, the shortness of the risers eliminates piping, and blind risers, and other special casting designs may be found unnecessary.

Metal & Thermit Corp., 100 E. 42nd St., New York 17, N. Y.

Circle No. 9 on Reader Service Card

CONTINUED ON PAGE 180

Tapered-Twisted Teeth

FOR MAXIMUM LOCKING EFFICIENCY!

EXTERNAL

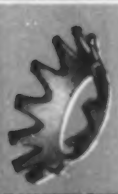
Shakeproof Lock Washers provide the vibration protection of tapered-twisted locking teeth at any fastening point.

INTERNAL

Each locking tooth actually bites into mating surfaces for positive resistance to loosening!

EXTERNAL–INTERNAL

Extra locking teeth help to span elongated holes and assure greater electrical contact efficiency.



COUNTERSUNK

Shakeproof Lock Washers assure positive vibration protection even with flatter oval head screws.

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LOCK WASHERS

a type and size for every locking need!

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Special arched shape provides extreme fastener resilience for shock resistance and vibration protection.

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Check the vibration hazards that attack every assembled product and see how Shakeproof Lock Washers lock three ways to eliminate these hazards. They actually lock tighter as vibration increases!

DOMED

The "dome" design distributes fastener stress over a wide area where extra tension is required.

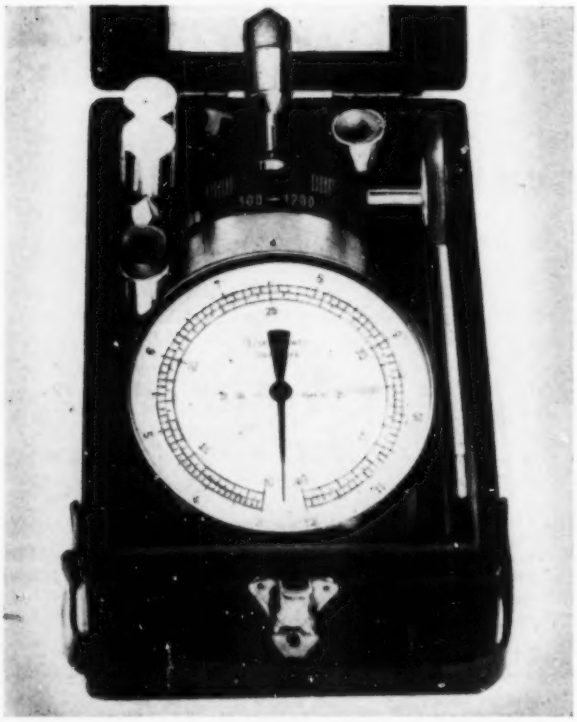
Let a Shakeproof engineer study your product to see if improved fastening methods can reduce your costs. Write for details, today!

SHAKEPROOF inc.

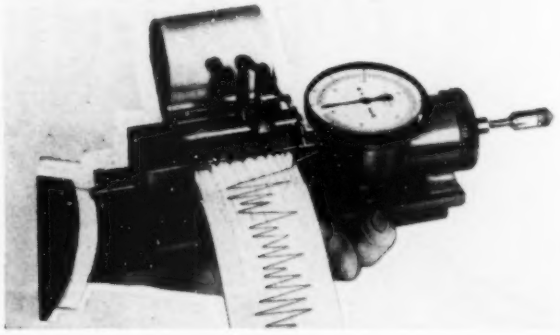
DIVISION OF ILLINOIS TOOL WORKS

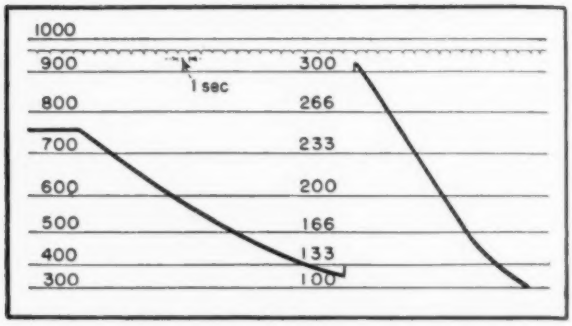
2501 North Keeler Avenue, Chicago 39, Illinois

In Canada: Canada Illinois Tools, Ltd., Toronto, Ontario



TACHOMETER showing the rotating gear shift set for one of the five ranges. In the case, to the left, can be seen the wheel attachment for indicating fpm.





SAMPLE CHART produced by the tachograph to show the shutdown curve of an a-c motor with exciter. Horizontal lines drawn by disks on the tachograph correspond to dial graduations.

Tachometer Shifts Into Five Speeds

Placed on the market recently has been a hand tachometer and a hand tachograph, the latter being a combination of the tachometer and a recording mechanism.

The tachometer, which is housed in an enamel finish aluminum alloy casting, has a three inch dia dial with an open scale and a knife edge pointer to permit reading between the lines. The spindle is made of hardened, ground steel and runs in ball, bronze and beryllium bearings. Between the spindle and the dial housing is the gear shift cap, a knurled ring on which are engraved five speed ranges. To shift from one range to another, the knurled ring is rotated until the desired range is in line with the dial center and a spring lock is felt to engage inside.

The indicating mechanism is actuated by a double cross pendulum with links operating the plunger on opposite sides, which, it is claimed, eliminates all side friction which might affect accuracy. To eliminate vibration of the indicating hand and make the tachometer "dead beat," a damping mechanism is built into the indicating train. It consists of a high speed light wind vane which is provided with beryllium bearings to overcome friction. This vane takes up shocks and vibrations and imparts a steady movement to the pointer without affecting the function of indicating speeds and speed fluctuations. The entire mechanism is balanced and end play is taken up by ball bearings.

These tachometers indicate directly either rpm or, with a wheel attachment, fpm in either direction. They come in three models, each with five ranges. One model can indicate speeds from 30 to 12,000 rpm, the second from 60-24,000 rpm, and the third from 120-48,000 rpm. The corresponding ranges of speeds in fpm of the three models are 15 to 6,000 fpm, 30 to 12,000 fpm and 60 to 24,000 fpm. Their accuracy is said to be within one-half of one percent. The tachometer is 5½ in. long and weighs 19 oz.

The tachograph, whose units are mounted on a metal base, is the tachometer described above modified to record its speed indications through a pen describing a pattern on the moving paper strip supplied by the recording mechanism. Paper travel and timing mechanism are wound by means of a removable key, shown at left. A long lever at left rear side of gear box (not visible in cut) starts and stops paper travel and pen. The short lever on top changes the speed of paper travel. Two speeds are provided: approximately ¼ in. per second on low and ½ in. per second on high gear. Other speeds and different timing units can be supplied on request.

The horizontal lines drawn on the paper strip by the disks correspond to the dial graduations. A calibrated scale is supplied to facilitate marking the speed values of the horizontal lines. The inking roller can be removed by pressing a spring lever. This, in turn, permits the removal of the disk roller for cleaning when necessary.

O. Zernickow Co., 15 Park Row, New York 7, N. Y.

Circle No. 10 on Reader Service Card

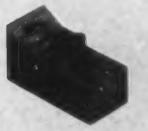
CONTINUED ON PAGE 182

Have you considered

CARBON-GRAPHITE

lately?

for molds



for dies

for liquid or gas seals

for ultra critical rheostats

. . . and for a host of problems involving friction, temperature, electric arcing or chemical action

Because carbon and graphite have many of the most desirable properties of both metals and non-metallic materials . . .

. . . And further, because a wide (but carefully controlled) variation of measurable characteristics can be obtained without significant change in their chemical composition . . .

. . . Stackpole carbon and graphite products provide outstanding efficiency and economy for a long list of chemical, electrical and mechanical developments.

Stackpole engineers welcome the opportunity to cooperate in solving the most modern design and engineering problems by skilled handling of these basic, highly versatile materials. Send details of your application for recommendation.

Write for
CARBON SPECIALTY
ENGINEERING
DATA BOOKLET 40

STACKPOLE CARBON COMPANY, St. Marys, Pa.

STACKPOLE

EVERYTHING IN CARBON BUT DIAMONDS

Compact Recording Oscillograph Saves Space

Compact, light-weight design and volume production have lowered the price on a recording oscillograph without sacrifices in quality or performance. Overall dimensions have been reduced from previous models and weight has been cut by almost 50 percent.

Basically, the instrument is comprised of two main castings, a webbed-base casting upon which are mounted all of the major components (with the exception of the optical system), and a front casting which uses the operational controls and the critical components of the permanently fixed optical system. Attached to this front casting, but easily and quickly removable, is the combination feed and takeup magazine which has a capacity of 125 feet of 5 in. wide recording material.

The magazine is made up of two castings: the main housing, and a coverplate. Such construction assures extreme rigidity and eliminates any possibility of misalignment from accidental rough handling. Neither sprocket teeth nor a pressure roller is required to provide positive record engagement, thus removing the major sources of record-drive malfunction, and at the same time reducing the power required to drive the recording medium.

It is possible to drive the record well in excess of 100 in. per sec and accurately maintain control. Sufficiently high record speeds make possible the recording of transient phenomena in minute detail. In order to utilize most conveniently the range of record speeds from ¼ to 100 in. per sec, a quick-change, ten-speed transmission is available in the instrument as an optional feature. The standard transmission makes use of change gears.

The source of power for the record transport system is a governor-controlled motor connected through gearing to the record drive roll in the magazine. Belts and friction drives are eliminated to give record acceleration without slippage, and maintain accurate speed control.

High-intensity light in controlled beams projects onto the galvanometers, eliminating objectionable stray light. The result is a record exhibiting fine traces with high definition. A prefocused galvanometer lamp provides a source of light for the galvanometers. Writing speeds of approximately 25,000 in. per sec on Eastman Linagraph 1127 are possible.

Standard practice in the record-numbering system requires two counters, operated in step, one for recording the record number and the other for visual indication of the same number. In the new design one of these counters has been eliminated, and means is provided for both viewing and recording the same counter.

Galvanometer Capacity—1 to 9 or 1 to 14

Record Speeds—¼ in. to 100 in. per sec

Record Magazine—Integral feed and takeup attached or detached to front—no threading of record required

Precision Timing—0.1- and 0.01-second timing lines

Automatic Record Numbering—One counter for viewing and recording

Record Indication—Unexposed footage indicated on magazine

Writing Speed—25,000 in./sec, standard
50,000 in./sec, optional

Power Required—24- to 28-v d-c, or 115 volt, 60 cycle a-c

Dimensions—Length 19½ in.; width 9½ in.; height 9 in.

Weight—48½ lb with full magazine

Consolidated Engineering Corp., 620 N. Lake Ave., Pasadena 4, Calif.

Circle No. 11 on Reader Service Card

SINGLE TURN POTENTIOMETER is equipped with ball bearings and contains multi-gang assemblies for independently phasing the individual sections. Two in. in diameter, it has resistances of 100 to 50,000 ohms and a five watt rating. Helipot Corp., South Pasadena, Calif.

Circle No. 12 on Reader Service Card

AIR LINE FILTER features a filtering element composed of hundred of laminations of a new material. Trapped moisture is removed through a drain cock. Filter comes in ¼, ⅜, and ½ in. standard pipe sizes. A. Schrader's Son Div., Scovill Mfg. Co., Inc., 470 Vanderbilt Ave., Brooklyn 17, N. Y.

Circle No. 13 on Reader Service Card

SINGLE PHASE CAPACITOR MOTOR has fingertip speed control, one piece cast iron drip-proof frame, Herringbone rotor, and Vinol-acetal insulated wire stator windings and utilizes a starting relay which eliminates centrifugal switches or rotating devices. It is available in ratings from ½ to 3 hp and at speeds from 52 to 2000 rpm. Sterling Electric Motors, Inc., Los Angeles 22, Calif.

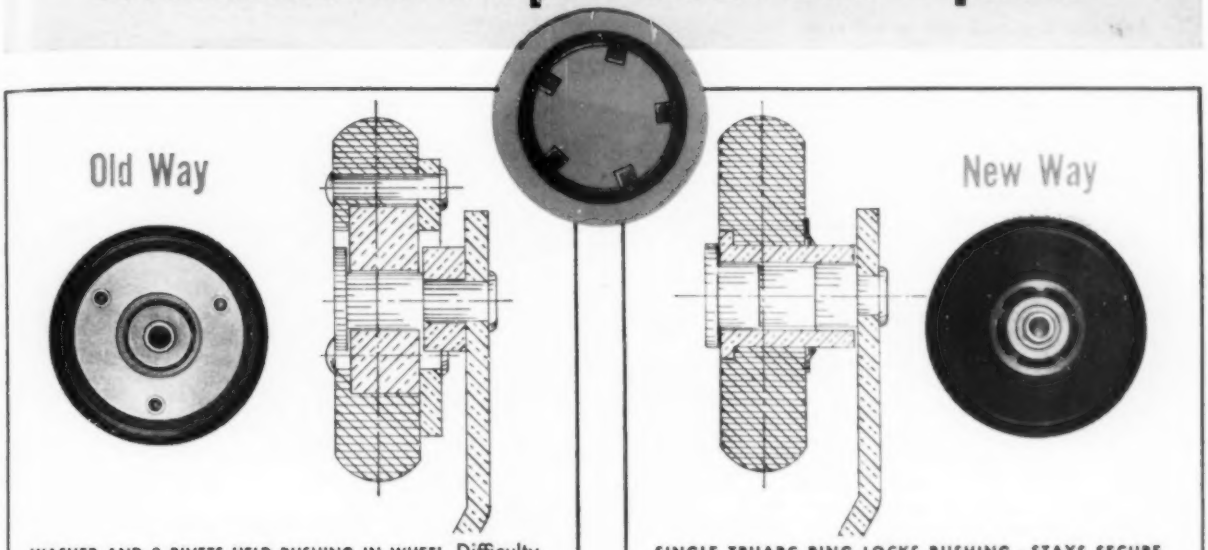
Circle No. 14 on Reader Service Card

VINYLITE INSULATION for 80 C and 105 C electrical applications such as radio hook-up wire, lamp ballast wire, and machinery wiring is a plastic compound which extrudes with a glossy, smooth surface in thin as well as thick wall sections and is free stripping. Bakelite Div., Union Carbide and Carbon Corp., 30 E. 42 St., N. Y. 17, N. Y.

Circle No. 15 on Reader Service Card

CONTINUED ON PAGE 184

Single Truarc Ring Slashes Unit Cost 44% ...eliminates 3 operations and 5 parts



WASHER AND 3 RIVETS HELD BUSHING IN WHEEL. Difficulty in accurate positioning of rivet holes caused rejects. Also rivets loosened in use.

SINGLE TRUARC RING LOCKS BUSHING—STAYS SECURE. Self-locking ring (type 5105) needs no groove. Replaces washer, 3 rivets, separate spacer.

Redesign with one Waldes Truarc Ring cuts cost of wheel used in Har-Vey Rolling Door Hardware (for residential doors) from 26.1¢ to 14.5¢—a 44% saving for Metal Products Corporation, Miami. Use of Truarc cuts manufacturing time 76%. Eliminates 5 separate parts, 3 press operations. And gives a product that stands up better in use!

Redesign with Truarc Rings and you too will cut costs. Wherever you use machined shoulders, bolts, screws, nuts, cotter pins, snap rings, there's a Truarc Ring that does a better job of holding parts together. Truarc Rings are precision engineered. They make assembly and disassembly quick and easy.

See what Truarc Rings can do toward cutting overall costs for you. Send your blueprints to Waldes Truarc engineers for individual attention, without obligation.

Redesign with Truarc self-locking ring produces these savings:

	saving
eliminates drilling 3 rivet holes	$.0042
eliminates riveting washer	.0111
eliminates punching washer	.00033
eliminates washer, spacer, rivets	.02236
cuts cost of inserting bushing	.00037
cuts cost of inspection	.0032
cuts cost of wheel, bushing, rivet	.0797
	.12126
less—cost of Truarc Ring	.00528
TOTAL SAVING PER UNIT 44%	$.11598

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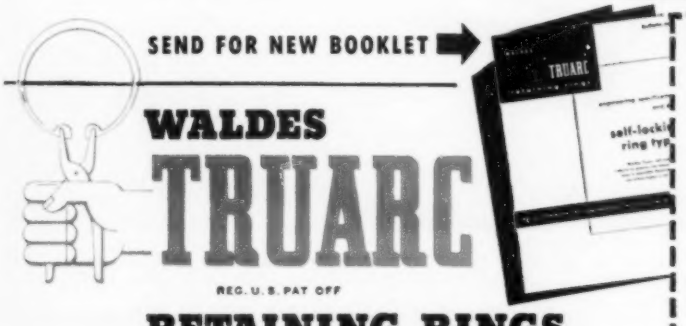


WALDES TRUARC

REG. U. S. PAT. OFF.

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS ARE PROTECTED BY U. S. PATS. 2,382,948; 2,416,852; 2,420,921; 2,411,761 AND OTHER PATS. PEND.

Waldes Kohinoor, Inc., 47-16 Austel Place PN-122
Long Island City 1, N. Y.

Please send Data Book on Waldes Truarc Self-Locking Ring Types.

Name_____

Title_____

Company_____

Business Address_____

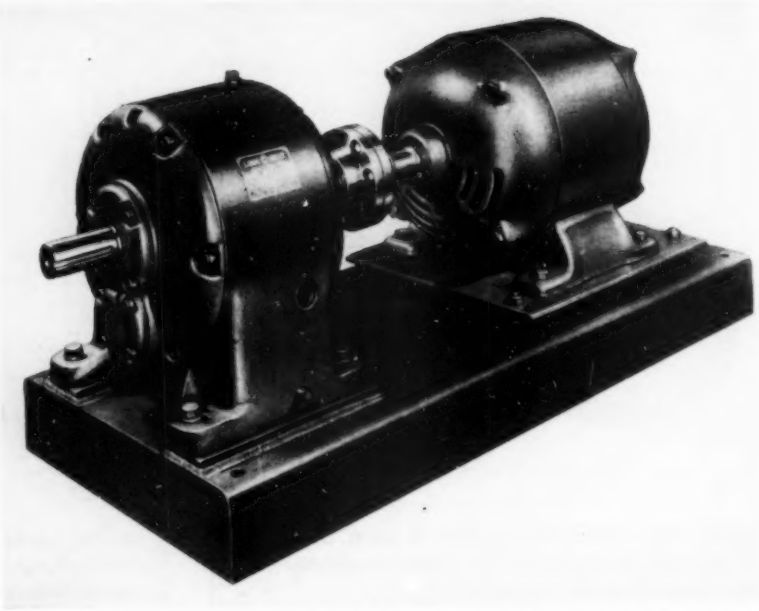
City_____ Zone_____ State_____

Gear Drive Coupled to Motor Forms Unit

Available is a packaged power unit whose purpose is to transmit power at a reduced speed. It consists of an enclosed helical gear drive with a separate motor flexibly coupled and mounted on a welded steel base plate. A movable plate between the motor feet and the base plate provides for adjustment should shaft realignment be necessary.

The grey iron gear drive housing is provided with seals to prevent oil leakage. All the gears are of the helical type cut from heat treated alloy steel and rigidly mounted. Both gears and bearings are automatically lubricated, the oil circulating freely through a reservoir. The base plate is designed for easy cleaning and is constructed to withstand overhung loads without deflecting. Motors are to be had with such enclosures as the open drip-proof type, the open splash-proof type, the enclosed non-ventilated type and the enclosed fan cooled type.

These power units are built in sizes ranging from 1 to 75 hp with output shaft speed ranging from 280 to 6 rpm.



Link-Belt Co., 307 N. Michigan Ave., Chicago 1, Ill.

Circle No. 16 on Reader Service Card

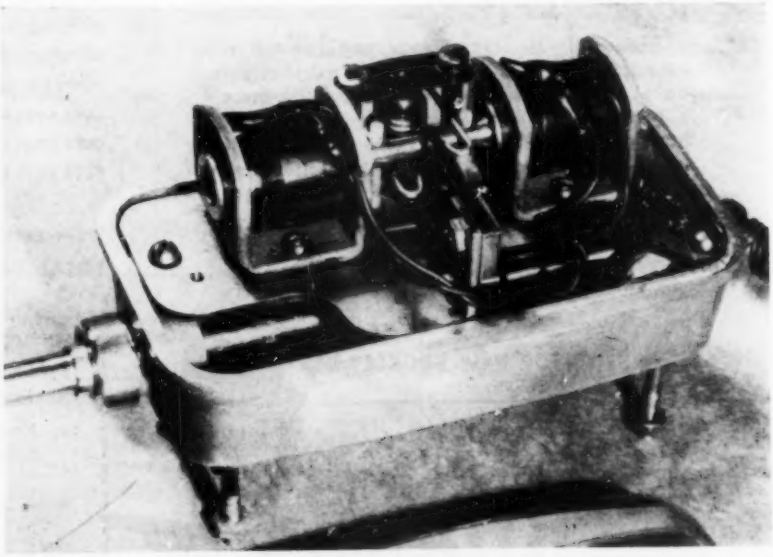
Variable Speed Motor Produces High Torque

Supplied in either uni-directional or reversible models, this motor operates at speeds from one-half to 100 rpm without using reduction gears. A feature is its high starting torque which at 35 watts, for example, is 80 in-lb at 1 rpm. The voltage required is either 6, 24, 115, or 220 v on 60 cycle a-c.

The standard model comes in a weatherproof die cast housing and requires no oiling. It is said that it will operate at high and low temperatures under extreme weather conditions.

Possessing the ability to be remotely controlled in much the same way as a servo mechanism, this motor will turn clockwise or counter-clockwise as desired and come to a stop in the same relative position as that for which the control has been set.

It is thought that applications for this product will be found in industries manufacturing antenna rotators, aircraft actuators, aircraft beacons, radio tuning and direction finding controls.



OPERATING at any speed up to 100 rpm and possessing high starting torque, this variable speed motor can be used in place of a servo mechanism in many applications.

Viking Tool & Machine Corp., 2 Main St., Belleville 9, N. J.

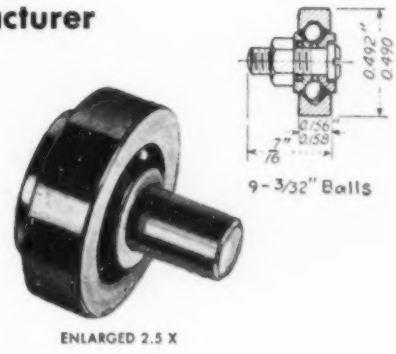
Circle No. 17 on Reader Service Card

CONTINUED ON PAGE 186

"Commercial" Ball-Bearing Data...#11 of a Series

WE WILL BE GLAD TO SEND YOU COPIES OF THE PREVIOUS ADVERTISEMENTS IN THIS SERIES.

How a special low-cost ball bearing helped an office-machine manufacturer control bearing end play



ENLARGED 2.5 X

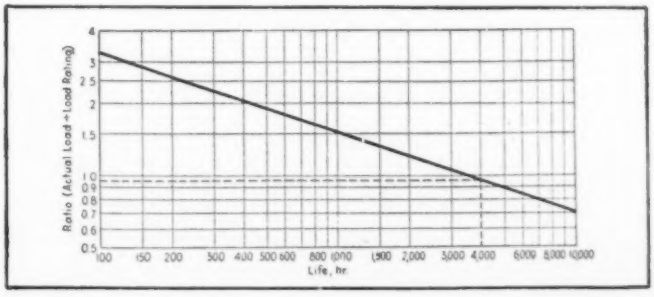
An office-equipment manufacturer needed a bearing whose width could be adjusted to control end play on a typewriter-like carriage operating at 600 r.p.m. under a 12-pound load. It had to be easy to mount and extremely rigid.

Schatz engineers designed a special "Commercial" ball bearing with a split inner ring separated by a compressible spacer and held together with a bolt that could be tightened or loosened, within limits, to vary the width. Maximum rigidity was provided by four points of contact for the balls.

This is typical of the kind of engineering thinking and knowledge that Schatz brings to a bearing problem. And Schatz special "Commercial" Ball Bearings—like the one shown—are often less expensive than standard bearings, since costly assembly and machining time is eliminated.

Many difficult anti-friction problems can be solved by various modifications in materials, inner and outer races, or the ball arrangement. All "Commercials" can be furnished with a single or double row of balls, felt or labyrinth seals, flanged or plain outside diameters, hardened or unhardened treads, set screws, Alemite fittings and extended inner race and hexagonal bores.

Let Schatz help you adapt or design a low-cost special ball bearing to fit your specific job requirements.



Average life rating of Schatz "Commercial" Ball Bearings, based on the ratio of actual service load to rated load of bearing. Bearings with highest load rating will give longest service.

Write for "Construction and Characteristics of Low-Cost Ball Bearings." It tells how to select low-cost Schatz "Commercial" Ball Bearings for various load and speed conditions, gives classifications of standard types for radial, thrust or combination loads, and discusses the modifications that can be made for special design, assembly or operating conditions. Ask for Catalog No. 11, too. It gives complete data on the whole "Commercial" line.

SCHATZ
"Commercial"
BALL BEARINGS

The Schatz Manufacturing Company
6758 FAIRVIEW AVENUE, POUGHKEEPSIE, N. Y.

Speed Can Be Varied Within Any Range

By combining into an integral unit two products, one, a variable ratio speed changer, and the other, any one of a group of fixed ratio drives, the manufacturer offers a speed changer whose ratio between its input shaft and its output shaft can be changed from one to six through a continuous variation up to six to one in any desired range.

The variable ratio speed changer is a friction drive having two drive disks contacting two rollers. The rollers are pivoted so they contact the disks at changeable radii to adjust for different speed ratios. The drive disks are equipped with "lock-up" cams which automatically increase the contact pressure on the rollers to minimize slippage over a wide range of output torque. This results in low losses at small output torque, together with a high torque rating. Permanently lubricated ball bearings are used throughout, and the rolling surfaces are hardened ball bearing steel, running dry. Setting can be changed while running or stationary, by means of a knob near the ratio scale which is situated on top of the unit. This unit can be supplied with a pivoted lever or sliding push rod speed adjustor, or the speed adjusting knob can be replaced by a spur or worm gear. The "lock-up" cams produce some torsional spring effect which may be objectionable at very low speeds or irregular loads. In such cases spring-loaded disks are available, but with sacrifice in maximum output torque.

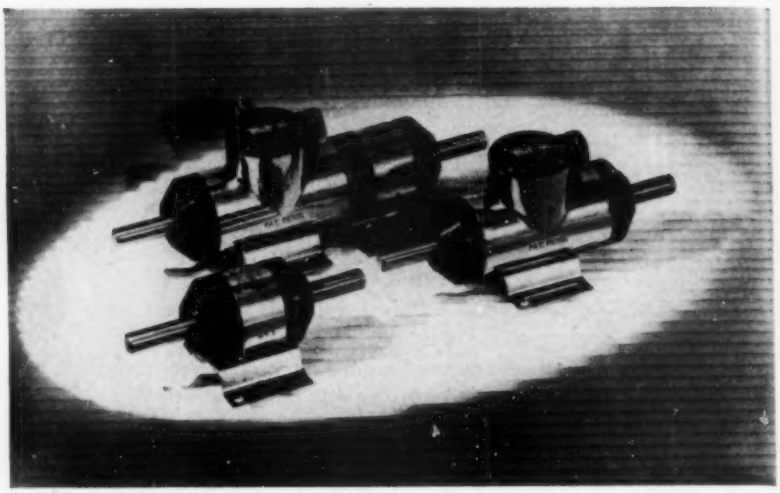
The fixed ratio reduction drives, which are described on page 162 in the April issue of Product Engineering, are to be had in either a series using extruded gears or in a more precise series using hobbed gears. Both are available in a number of ratios ranging from 1 to 1 up to 531,441 to 1. The shafts and counter-shafts are made of stainless steel and they and the ball bearings are permanently lubricated. Case hardened steel spur gears of the same diamentral pitch are used in the gear train.

As examples of the combinations available, an 1,800 rpm motor will deliver through a unit made up of the variable ratio speed changer and a fixed ratio drive with a reduction of two to one all the output speeds between 150 rpm and 5,400 rpm. With the same motor, by combining with the variable ratio speed changer a fixed ratio drive with a reduction of 531,441 to 1, all the output speeds between 0.6 revolutions per day and 20 revolutions per day can be secured.

For best general performance and maximum output torque over a wide speed range, the variable unit should be on the input or high speed side with the fixed ratio unit used as a speed reducer on the output side. Where only part of the total speed range is required, it is best to use the range near 1 to 1 and on down into the speed reduction range for highest efficiency. Where the driving speed is more than 3,600 rpm and full 36 to 1 speed adjustment is required, a single section reducer must be placed between the variable unit and the input to keep the output speed below 20,000 rpm. The body length with one geared section is 3 21/32 in. Each additional section increases the length 13/16 in.

Metron Instruments Co., 432 Lincoln St., Denver 9, Colo.

Circle No. 18 on Reader Service Card



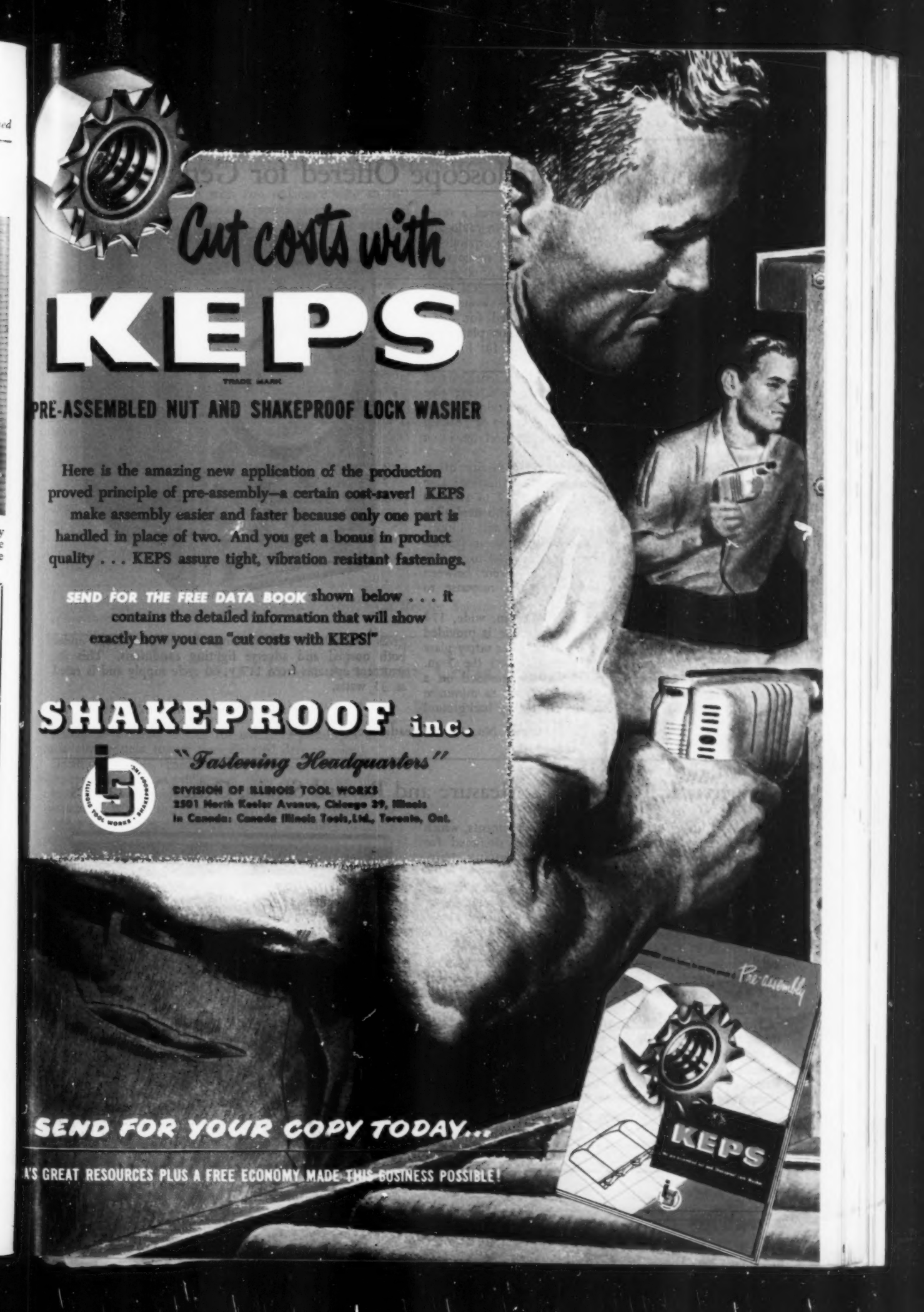
THE SPEED CHANGER is displayed in the center. It is an integral unit produced by combining the variable ratio speed changer shown to the right and a fixed ratio drive shown to the left. A wide variety of speed ranges can be achieved by using any one of a series of fixed ratio drives.

GENERAL SPECIFICATIONS

NOMINAL MAXIMUM OUTPUT—.025 HP
NOMINAL EFFICIENCY RATING—70%
NOMINAL SLIP AT RATED OUTPUT—9
MAXIMUM SPEED OF EITHER SHAFT—20,000 rpm
RANGE OF SPEED ADJUSTMENT—Ratio continuously variable from 1/6 to 6 by 18 turns of the adjusting knob.
ADJUSTMENT KNOB TORQUE REQUIRED—1 oz-in.
ROTATION—Either direction. Input and output shafts rotate in opposite directions.
ORIENTATION—May be operated in any position. Either end may drive or be driven.
BACK LASH—None. Torsional spring effect between shafts due to lock-up mechanism (at ratio of 1 to 1) is approximately 1.5 degrees per ounce-inch.
LUBRICATION—Permanent. Shielded ball bearings.
WEIGHT—5.5 oz.

THESE SPECIFICATIONS are for the variable ratio speed changer. Those for the fixed ratio drive units are to be found in brief in the April issue of PRODUCT ENGINEERING on page 162. The combination unit has the characteristics of both.

CONTINUED ON PAGE 188


Cut costs with
KEPS
TRADE MARK
PRE-ASSEMBLED NUT AND SHAKEPROOF LOCK WASHER
Here is the amazing new application of the production proved principle of pre-assembly—a certain cost-saver! KEPS make assembly easier and faster because only one part is handled in place of two. And you get a bonus in product quality . . . KEPS assure tight, vibration resistant fastenings.
SEND FOR THE FREE DATA BOOK shown below . . . it contains the detailed information that will show exactly how you can "cut costs with KEPS!"
SHAKEPROOF inc.
"Fastening Headquarters"
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Pre-assembly
KEPS
SEND FOR YOUR COPY TODAY...
A'S GREAT RESOURCES PLUS A FREE ECONOMY MADE THIS BUSINESS POSSIBLE!

Cathode Ray Oscilloscope Offered for General Use

Laboratories, factories, and schools are offered a seven inch cathode ray oscilloscope for general use in radio and television servicing . The new instrument incorporates a multivibrator sweep circuit for linear internal sweep from 10 to 30,000 cycles which may be synchronized to 60 cycles, an external signal or signal applied to its vertical input terminal. Balanced, non-astigmatic sweep is assured by push-pull deflection. Terminals are provided for direct connection to horizontal and vertical deflection plates and to the control grid of the cathode ray tube for intensity modulation.

The vertical deflection amplifier provides a sensitivity of 0.1 volt rms for one inch peak-to-peak deflection; sine wave frequency response at full gain flat within 3 db of 1,000 cycles value from 7 to 70,000 cycles free of peaking and useable to much higher frequencies; and an input impedance of ½ megohm and 34 mmf.

The horizontal amplifier provides a sensitivity of at least 0.25 v rms for one in. peak-to-peak deflection; sine wave frequency response within 3 db from 7 to 120,000 cycles; a total deflection of at least 8½ in. with negligible distortion; and input impedance of ½ megohm and 34 mmf.

Horizontal sweep characteristics include: linear (multivibrator) saw-tooth sweep, left right, from 10 to 30,000 cycles; non-linearity not exceeding 10 percent between rated limits at any sweep frequency; and response to positive synchronizing signals.

This oscilloscope is 17 1/16 in. high, 11⅜ in. wide, 17¾ in. deep and weighs 39 lb. The steel cabinet is provided with grey wrinkle finish, and ⅛ in. thick, clear safety glass and an impact resistant rubber mount protect the 7 in. cathode ray tube face. Cross-hatching is provided on a plastic sheet inserted behind the safety glass to minimize parallax. Jet-black panel lettering on a grey background

gives contrast for easy reading of control settings under both normal and adverse lighting conditions. This instrument operates from 117 v, 60 cycle supply and is rated at 35 watts.

Sylvania Electric Products Inc., Emporium, Pa.

Circle No. 19 on Reader Service Card

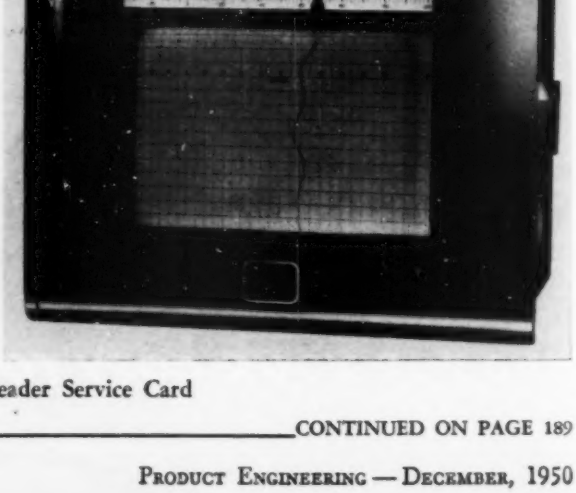
Electronic Instruments Measure and Record Strain, Other Variables

Here is a line of strip-chart electronic instruments, which are high-speed, self-balancing a-c bridges designed for measurement of temperature, resistance, conductivity, strain, position, inductance, pressure, force, or any other variable which can be measured in terms of impedance. In addition, the instrument can be used for electric power totalization.

The measured variable is recorded on a chart 11¼ in. wide and indicated on a scale which is legible at a distance. In addition to the single record model, instruments are available for 16 different records on the same chart. Models are offered for full-scale pen travel in 7 records, 3 seconds and ¾ sec, with a range of standard chart speeds from 1 in. per hour to 120 in. per minute.

These instruments are housed in a moisture-, fume-, and dust-proof case suitable for wall, flush-panel, or front-of-panel mounting. The scale and recording mechanism are mounted on the front of a hinged, aluminum alloy panel, which can be swung out to gain access to the electronic components or the control mechanism.

The Bristol Co., Waterbury 20, Conn.



Circle No. 20 on Reader Service Card

CONTINUED ON PAGE 189

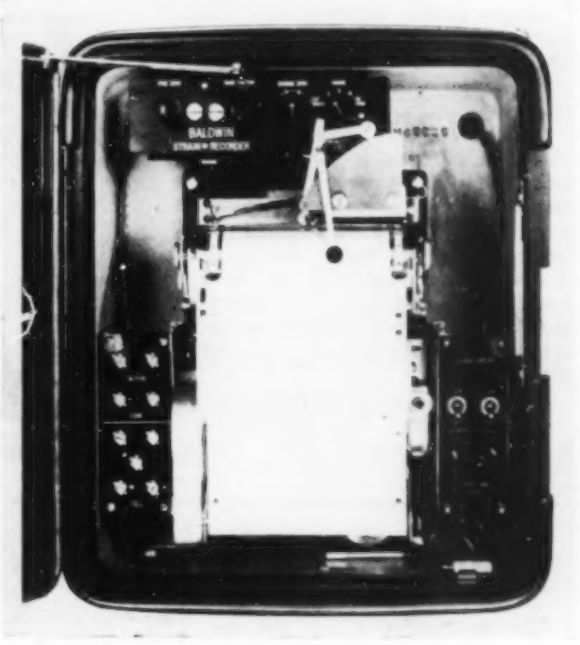
Electronic Recorder Measures Surface Strain

For use in conjunction with two resistance wire strain gages manufactured by the same company, there is available a strip chart recorder for continuous measurement of surface strain in structures or machines. It is an electronics type instrument having a resistance of 120 ±1.2 ohms and a sensitivity factor between 1.9 and 2.2.

Available ranges in the instruments are 0.2000, 0.5000, and 0.10,000 micro-inches per in. It provides ten chart speeds within a range of ¾ in. to 720 in. per hour. The pen moves across a 4½ in. wide chart in a straight line making coordinated readings of time vs strain. The pen may be zeroed at any point on the chart and the instrument range can be changed during a measuring run if zero adjustment settings for all three ranges have been initially determined. Instruments are available with full scale traverse speeds of one, three or five seconds without overshoot.

Controls and adjustments for gage factor, range, and coarse and fine zero settings are grouped across the top of the instrument inside the door. Precision measurement of gage resistance variations is made by a 1,000 cps bridge circuit. Electronic parts of the instrument are mounted on the back of the case, protected by a gasketed cover. Accuracy of measurements in all usual applications is not affected by amplifier tube characteristics or changes, nor by normal power variations.

Baldwin Locomotive Works, Philadelphia 42, Pa.



Circle No. 21 on Reader Service Card

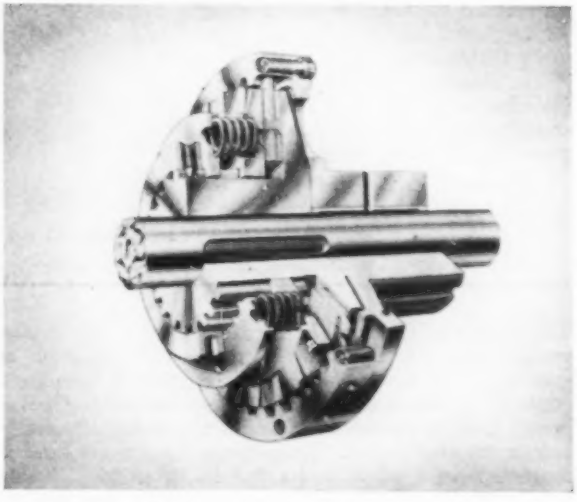
Slip Clutch Maintains Constant Torque

Although designed to maintain constant tension or constant torque on winding operations, this slip clutch can also be used as a safety device for overload protection or to maintain constant torque regardless of driving speed.

Features include ventilated plates, cooling fins and pressure springs with long deflection range for accurate adjustment. Single, double and triple plate construction is available. When the function is constant tension, the regular adjusting nut is replaced with a sliding collar to permit adjustment while the unit is in operation.

Some models are constructed with a disk spring and metallic friction plates in a compact design to fit small space. High grade iron or aluminum castings and steel is used for the parts and exposed surfaces can be cadmium plated for corrosion resistance where necessary. The clutches are offered in sizes from 2⅜ dia to 27 in. dia with torque range up to 10,000 ft lb and heat capacity up to 8½ horsepower. This product will find application in the printing, paper making, plastics, and textile industries.

Hilliard Corp., Elmira, N. Y.



Circle No. 22 on Reader Service Card

CENTRIFUGAL CASTINGS of bronze alloys such as liners, sleeves, rolls, rings, and bushings can be produced, either rough or machined, in sizes up to 12 inches OD and 13 inches long. American Non-Gran Bronze Co., Berwyn, Pa.

Circle No. 23 on Reader Service Card

SHIM STOCK made of spring-tempered, stainless steel is available in thicknesses from .001 in. to .031 in. Precision Steel Warehouse, Inc., 4409-4425 W. Kinzie St., Chicago, Ill.

Circle No. 24 on Reader Service Card

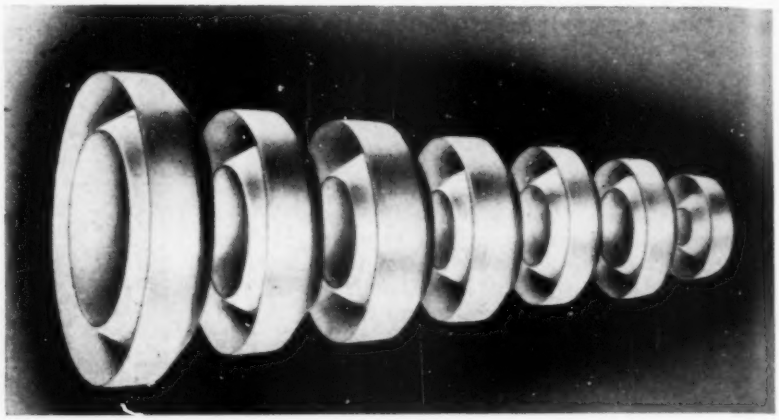
CONTINUED ON PAGE 190

Teflon V-Rings Withstand Temperature and Corrosion

Here is another Teflon packing, the molded V-ring type, which has a cross section designed to insure permanent sealing, even under varying pressures, at temperatures up to 450 F.

The combination of properties of Teflon includes low friction characteristics, the ability to withstand higher temperatures and corrosive chemicals, and the resilience and toughness needed for proper sealing results. It is claimed that these rings will stand up several times longer than conventional packings and form a perfect seal with finger-tight pressure on the gland.

Crane Packing Co., 18 Cuyler Ave., Chicago, Ill.



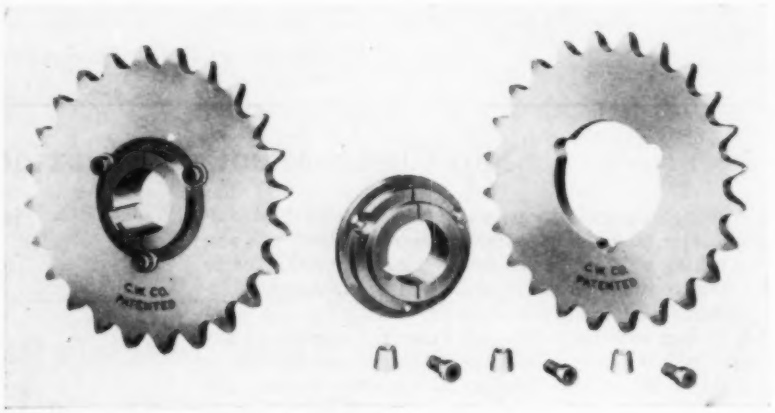
Circle No. 25 on Reader Service Card

Now Disk Sprockets May Have Interchangeable Hubs

The photograph reveals the simplicity of these interchangeable hubs for disk sprockets. The sprocket is placed on the hub, the taper bushings are inserted, the head cap screws are tightened, and the assembly is ready for mounting on the shaft. Where conditions permit, plate sprockets may be interchanged and mounted without removing the hub. The hubs are available in a range of sizes.

The manufacturers claim that these interchangeable hubs for disk sprockets contribute an economical unit to the power transmission industry.

Cullman Wheel Co., 1344 Altgeld St., Chicago, Ill.



Circle No. 26 on Reader Service Card

THERMOMETER held in place by spring pressure in a light-weight noncorroding case, from which it can be removed or into which it can be replaced easily, is carried like a fountain pen in the coat pocket. Temperature range is from —30 F to +120 F in 2 F increments. Tagliabue Instrument Div., Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.

Circle No. 27 on Reader Service Card

ELECTROSHIELD SHEET consisting of a core of mild steel clad on each side with copper is claimed to improve the performance of electronic communication equipment by shielding it from outside interference and by making possible wider frequency ranges. It comes in regular sizes and gages and can be worked and welded. American Cladmetals Co., Arch St., P.O. Box 544, Carnegie, Pa.

Circle No. 28 on Reader Service Card

FAST-DRYING ENAMEL dries to handle in a half-hour and dries hard in eight hours to form a tough resilient film with a dielectric strength of 800 v per mil. It bonds well to insulating materials and metals and is resistant to oils, moisture, chemicals and abrasive dust. Irvington Varnish & Insulator Co., 6 Argyle Terrace, Irvington 11, N. J.

Circle No. 29 on Reader Service Card

TEFLON - JACKETED GASKETS have a seamless, one-piece, machined Teflon jacket with a heavier wall of Teflon on the inside diameter. They come in hard, medium and soft grades and in sizes from ½ to 6 in. ID. Solid Teflon gaskets are also available. Chicago Gasket Co., 1275 W. North Ave., Chicago 22, Ill.

Circle No. 30 on Reader Service Card

CONTINUED ON PAGE 192

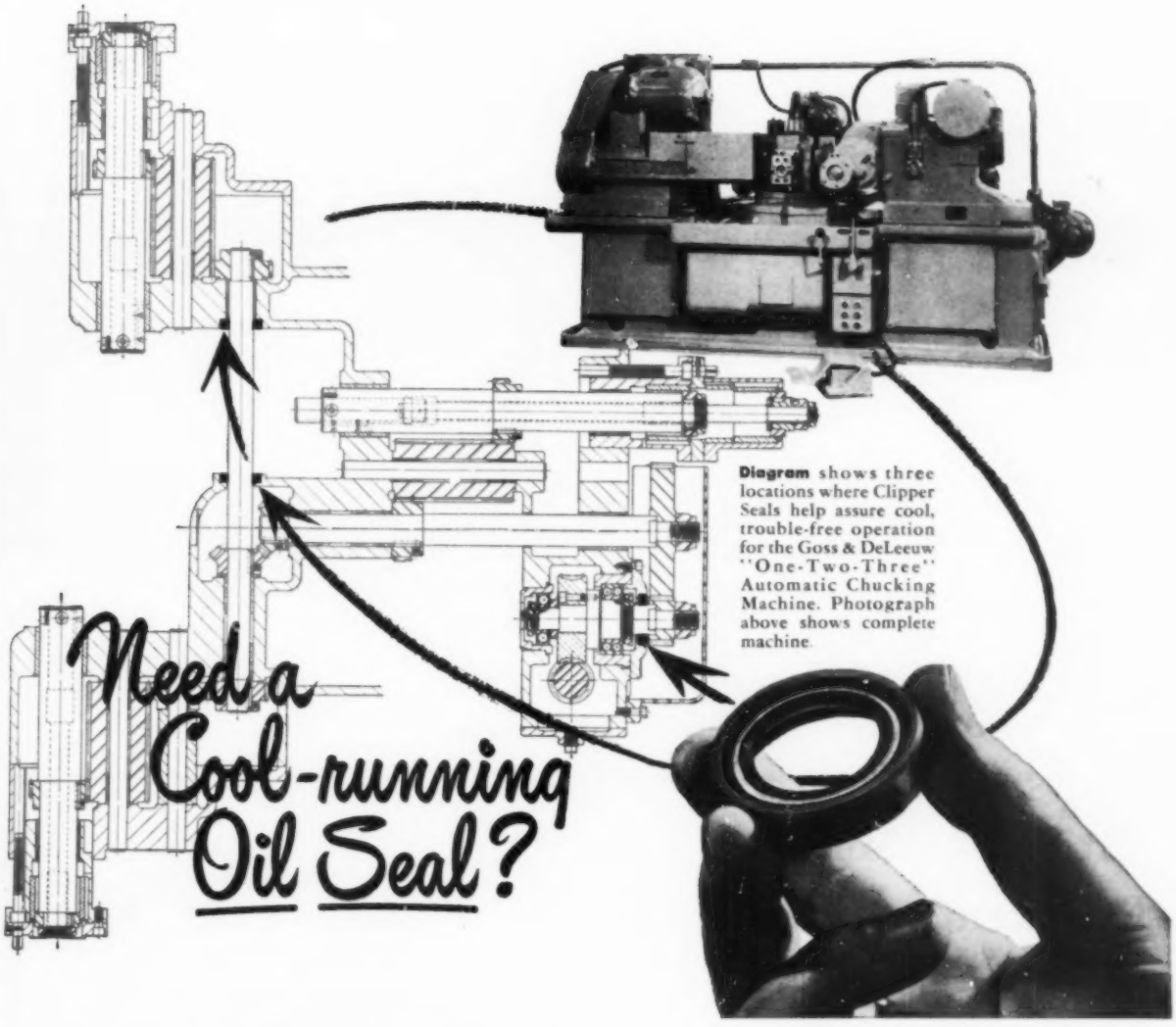


Diagram shows three locations where Clipper Seals help assure cool, trouble-free operation for the Goss & DeLeeuw "One-Two-Three" Automatic Chucking Machine. Photograph above shows complete machine.

Need a Cool-running Oil Seal?

Goss & DeLeeuw turns to Clipper Seals

IF YOU'RE SEARCHING for an oil seal that you can depend on to run cool... thereby minimize friction and shaft wear, and last longer . . . you'll be interested in hearing why The Goss & DeLeeuw Machine Company selected Clipper Seals for their "One-Two-Three" Automatic Chucking Machine.

The "One-Two-Three"—a revolutionary contribution to the metal working field which permits machining three-faced parts in a single operation—required an oil seal that would minimize friction and wear at high shaft speeds. It would also have to do a highly efficient job of keeping lubricants in place.

After careful tests, Goss & DeLeeuw found that the simple design of the Clipper Seal decidedly reduces friction and wear . . . assuring cool, trouble-free ope tion plus a long service life. They found, too, that Clipper Seal's tough, dense heel gives the rigidity necessary for a press fit in the cavity . . . while the flexible lip, held in light but positive contact with the shaft by a specially designed garter spring, provides effective sealing at all times.

The solution to *your* sealing problem may be this all-round efficiency of Clipper Seals. They come in a variety of precision-moulded designs . . . in sizes to fit shaft diameters from ¼" to 66", for temperatures to 450F, and for shaft speeds to 3500 rpm. Get compl te information by writing for Brochure PK-46A. Address Johns-Manville, Box 290, New York 16, N. Y.

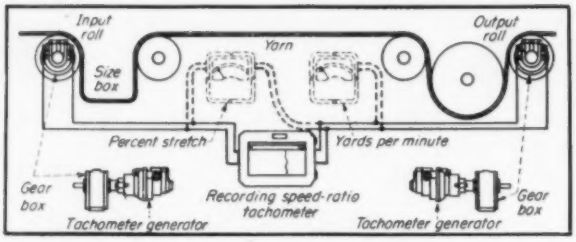
JOHNS-MANVILLE JM PRODUCTS

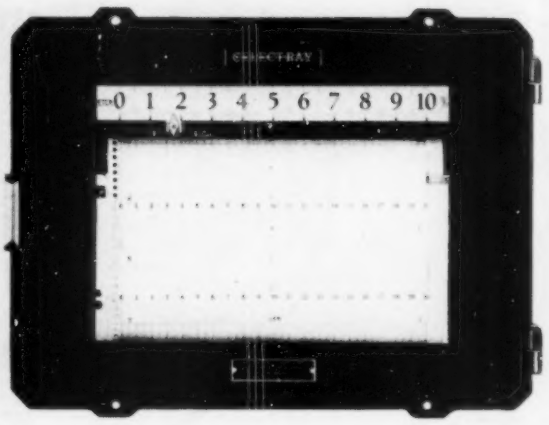
Johns-Manville CLIPPER SEALS

Tachometer Records Stretch or Shrinkage

The percentage stretch or shrinkage of materials being processed through pairs of rolls turning at different speeds is indicated and automatically recorded by a recording speed-ratio tachometer now on the market. The instrument provides a continuous record of roll speed ratio for textile, paper, plastics, rubber, chemical and metal-rolling industries.

Operated by two of the manufacturer's tachometer generators driven by the respective rolls, the unit can be calibrated in percent stretch as in yarn processing, inches per yard shrinkage as in fabric Sanforizing, percentage reduction as in metal rolling, or other units which are a function of the speed ratio between two rotating members.





Tagliabue Instruments Div., Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

Circle No. 31 on Reader Service Card

Attenuator Meets Requirements Where Space Is Tight

In line with the present trend toward miniaturization of components, there has been developed a "T" network attenuator measuring 2¼ in. in diameter which has 30 steps of attenuation. It is believed that this is the smallest size in which a unit of this type has been manufactured. Characterized by zero insertion loss and constant input and output impedance this electrical unit, which would be of use where space is of prime importance, is available in levels of 0.5, 1.0, 1.5, and 2.0 db. It has a flat frequency characteristic to 30 kc but can be ordered with a frequency range extending to 200 kc. Resistance accuracy is ±5 percent although, on request, this can be reduced to ±0.1 percent.

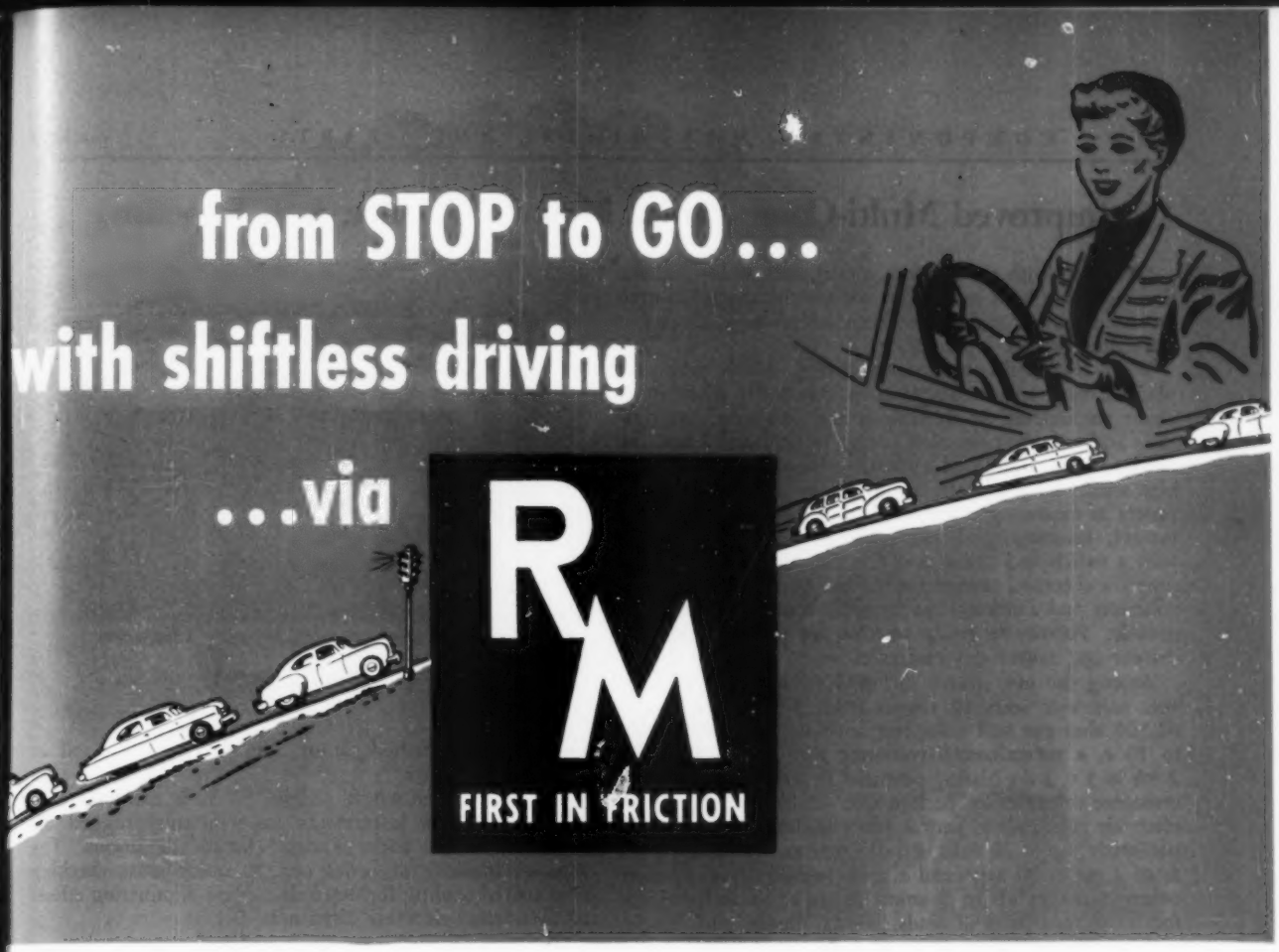
The rotor is enclosed in a tamper proof housing. Oilite bearings are provided to prevent the shaft from freezing or binding. Each blade of the rotor is individually spring loaded to maintain uniform contact pressure and low contact resistance during the life of the unit. Short rotor arms have been incorporated in the attenuator in order to provide a short inductive path and a good frequency characteristic. The contacts are silver alloy. To make the unit dust proof and vibration proof, a two piece dust cover encloses it and is held on by a bayonet type lock.

ALTHOUGH MEASURING ONLY 2¼ IN. IN DIAMETER, this miniature attenuator has 30 steps of attenuator. The rotor, which turns in oilite bearings, has individually spring loaded blades and short rotor arms. The contacts are silver alloy. Seen behind the attenuator is its cover with the bayonet type lock. This cover makes the unit dust proof and vibration proof.

Daven Co., 191 Central Ave., Newark 4, N. J.

Circle No. 32 on Reader Service Card

CONTINUED ON PAGE 194



More and more American motorists call for automatic transmission . . . and the industry meets the demand! Production of automatic units keeps going up . . . up . . . up. R/M plays an interesting part. *Every* automatic transmission now in production employs friction material made by R/M, the largest producer in the field. Some of these materials are woven, some molded; some are compounded, in whole or in part, of powdered metal; many are bonded to metal backings. Other R/M products are used constantly for clutches and brakes covering an even wider range. The experience thus gained is available to all manufacturers faced with problems in metallic and asbestos friction materials, as well as in rubber products. Your R/M representative is the man to see!

RAYBESTOS-MANHATTAN, INC.

EQUIPMENT SALES DIVISION **620 Fisher Bldg., Detroit 2, Mich.**

445 Lake Shore Drive, Chicago 11, Ill. 4651 Pacific Blvd., Los Angeles 11, Calif.

1071 Union Commerce Bldg., Cleveland 14, Ohio

Factories: Bridgeport, Conn. Manheim, Pa. Passaic, N.J. No. Charleston, S.C.

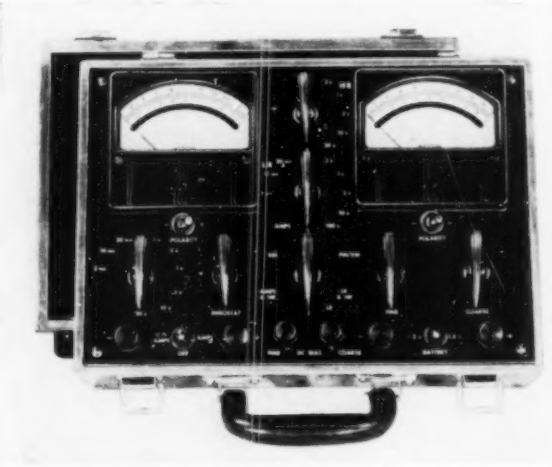
RAYBESTOS-MANHATTAN, INC., Manufacturers of Brake Linings • Brake Blocks • Clutch Facings Fan Belts • Radiator Hose • Mechanical Rubber Products • Rubber Covered Equipment • Packings Asbestos Textiles • Powdered Metal Products • Abrasive and Diamond Wheels • Bowling Balls

Improved Multi-Combination Meter is Smaller, Less Expensive

Compared with the previous model, this multi-combination meter has been reduced in size yet the range has been increased, mirror scales have been added, and accuracy is maintained within 1 percent.

With this multi-combination meter, which takes the place of many separate instruments, practically all measurements encountered in electrolysis and corrosion investigations and cathodic-protection testing in field and laboratory can be made. By use of a circuit selector switch, the two high-sensitivity d-c instruments can be connected into a variety of measuring circuits for measurement of potentials, current, resistance and soil resistivity. Internal batteries with a switch and coarse and fine controls can be used to supply and control current for test purposes. Voltmeters, or voltmeter and ammeter, can be used separately or simultaneously. Polarity reversing switches are provided for both current and potential measurements.

Among the instruments included are a 1,000 ohm per volt voltmeter with 10 ranges from 2 mv to 100 v, a 62,500 ohm per volt voltmeter with six ranges from 0.1 to 20 v, a potentiometer-voltmeter with six ranges from 2 mv to 3 v, a d-c biasing potential in series with the high resistance voltmeter to "back-to-zero" residual earth, pipe or electrode potentials to permit direct readings of "change-in potentials" up to 20 volts, a milliammeter with nine ranges from 2 ma to 20 amp, and a zero-resistance type ammeter covering ranges up to 5 amp. A circuit is included for measuring resistance of leads, bonds, shunts, and flanges, and for measuring resistivity of soil to any depth by the four electrode method, or of a small sample of soil or water in a soil box.



The instrument which weighs 12 lb is mounted in a sturdy case. The instruments are sufficiently rugged for use in field work under extreme climatic conditions. The accurate linearity of scales permits quick cross checking of potential reading for determining and eliminating effects of circuit and electrode resistance.

M. C. Miller, 1142 Emerson Ave., West Englewood, N. J.

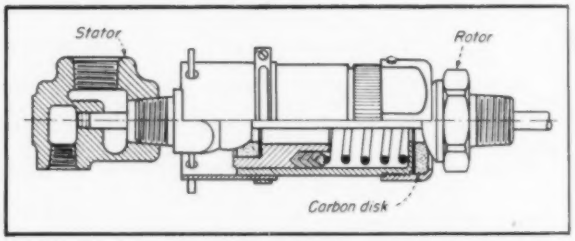
Circle No. 33 on Reader Service Card

Spring Loaded Carbon Disk Seals Rotating Joint

All packings in the joint are stationary seals; rotation takes place only on a non-porous carbon disk. The piping is permanently installed and is not taken apart when the joint must be replaced. Rotating speeds up to 1,000 rpm can be handled. The joint can be disassembled and cleaned daily in applications handling paint and food products.

The cartridge is installed between two rigid pipe balls, allowing one connection to rotate freely. Misalignment in the pipes is compensated for at installation by flexing of the joint. Spring tension holds the carbon disk rotating seal against the rotating ball.

Steam, air, oil, gas or water can be handled from —40 to 450 F, without lubrication. Operating pressure is 150 psi max for steam, 300 psi for hydraulic oil and chemical service. Joints come in ½, ¾ and 1 in. pipe sizes.



CARTRIDGE assumes any position between the ball seats, adjusting for pipe misalignment. Packings are stationary, while the joint rotates on carbon disk seal, held tight by spring pressure.

Rotherm Engineering Co., Inc., 4911 W. Irving Park Rd., Chicago 41, Ill.

Circle No. 34 on Reader Service Card

HAND SEALER FOR POLYETHYLENE is claimed to have overcome the problems of polyethylene sticking to the sealing iron. The light weight of its spring mounted Teflon frame permits day-long use without fatigue. The seals it provides are neat and secure without requiring excessive pressure application or heat dwell time. The sealing bar is 8 in. long and ⅛ in. wide. Amsco Packaging Machinery Inc., 31-31 48th Ave., Long Island City, N. Y.

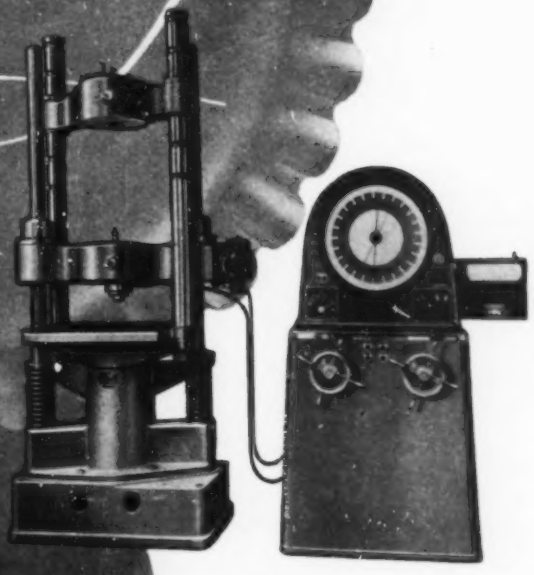
Circle No. 35 on Reader Service Card

A-C SOLENOID, has a 1⅜ in. stroke with constant duty pull up to 16 lb and intermittent duty pull up to 29 lb. Features include high sealing pull, low heating. Soreng Mfg. Corp., 9555 Edin Ave., Schiller Park, Ill.

Circle No. 36 on Reader Service Card

CONTINUED ON PAGE 196

Quality



Baldwin—Tate—Emery Universal Testing Machines

Tate-Emery weighing system, entirely separate from loading system . . . Servo drive provides outside source of power, overcomes drag, provides excess energy to operate maximum hand, recorder, load maintainer and other auto-control . . . multi-range dial . . . selection variable during test . . . widest span of ranges—200 to one or greater . . . accuracy of ½% guaranteed down to 20% of each range . . . ASTM accuracy guaranteed to 10% of each range . . . demonstrated sensitivity shows 1 pound in a million . . . zero essentially positive . . . negligible hysteresis, creep or temperature errors . . . complete calibration and maintenance service . . . installation by a qualified Baldwin field engineer.

THE BALDWIN LOCOMOTIVE WORKS
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Offices: Chicago, Cleveland, Houston, New York, Philadelphia, Pittsburgh, San Francisco, St. Louis, Washington.
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FOR
PERFORMANCE
90% LONGER LIFE
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You are not buying bearings, you are buying performance . . . bearing life, load capacity, quietness. In performance Hoover, America's only ball bearing with honed raceways, gives you the most for your money. When you specify and buy Hoover Ball Bearings you buy unbelievable quietness plus 90 per cent longer life, 30 per cent greater load capacity. A growing list of distinguished American manufacturers of quality machines and equipment are finding that their bearing dollars buy more value when they select Hoover.
Engineering and purchasing executives are invited to write for the Hoover Engineering Manual.
THE ARISTOCRAT
OF BEARINGS
HOOVER BALL and BEARING CO.
Ann Arbor, Michigan

Cartridge Type Filtering Medium Purifies Oil

Four and one-half lb of Palconia, a filtering medium composed of a blended cellulose fiber, is packed into a woven cotton sock material around a fiber center tube to form this oil purification cartridge. In operation,

oil passes through the cotton sock and cellulose whose uniform porosity insures removal of solids, abrasives, scale and other foreign matter. Since the center tube is made of fiber, the whole unit can be disposed by burning. It is claimed that this cartridge will maintain any type of oil in approximately new condition indefinitely.

Honan-Crane Corp., Lebanon, Ind.

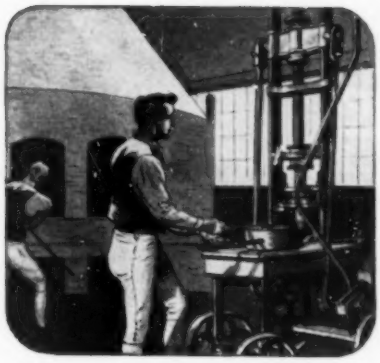
Circle No. 37 on Reader Service Card

Copper Clad Aluminum Solves Electrical Problems

Aluminum sheet or tubing is clad on one or both sides with copper by a solid phase bonding process which, it is claimed, assures the absence of voids, oxides and compound inclusions and gives the bond a strength equivalent to aluminum.

Because the bonding conditions offer no resistance between the copper and aluminum layers, this composite metal is a good conductor of electricity. In the electrical field, it can be used to advantage for clips, shims, bushings and terminals. In the termination of aluminum conductors, for example, the aluminum core of this composite metal provides the necessary aluminum to

1 1621—Glass was money! America's first glass factory was actually a mint—not for the manufacture of coins but to make glass beads for use as money when buying land, food and furs from the Indians.

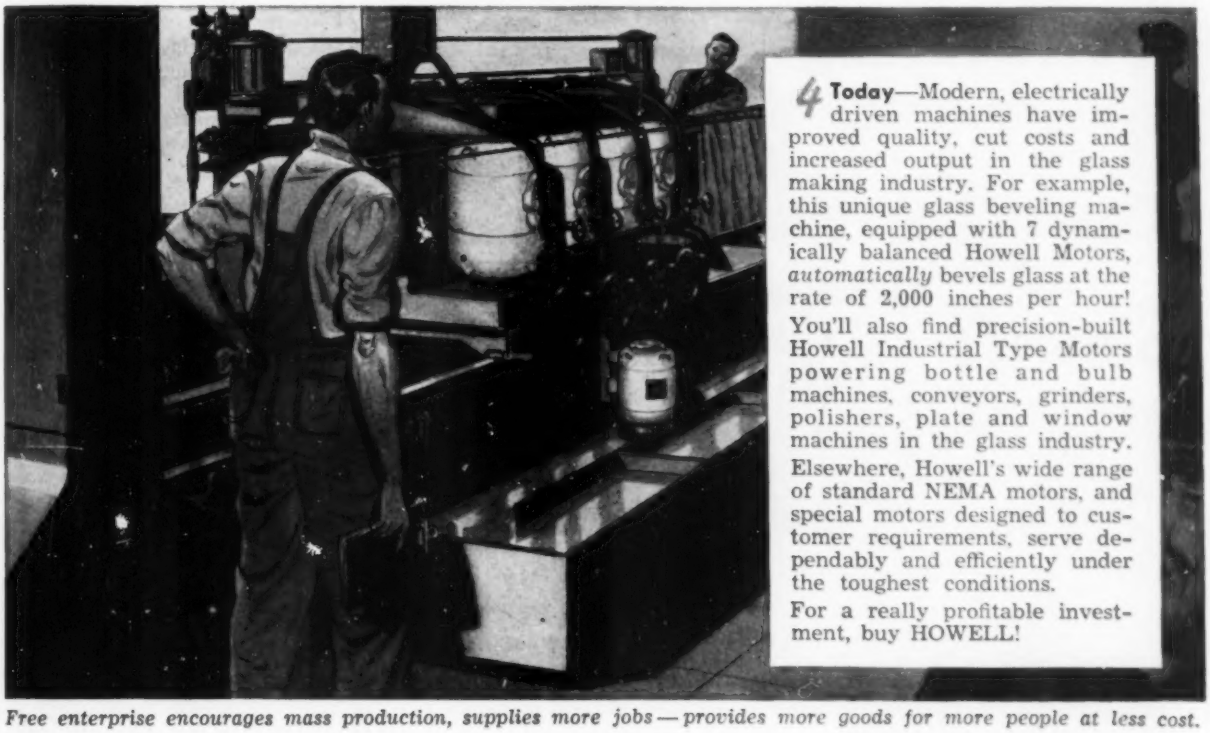


2 1827—Blown glass was the rule until Enoch Robinson, a carpenter, figured glass could be *pressed* into shape . . . the glass pressing machine was born. Electricity to power new machines was still to come.

3 1899—Owens invented a machine to make bottles as the machine age arrived in glass. By 1915, Howell "Red Band" Motors were making important contributions to this and other industries.

ANOTHER HOWELL SUCCESS STORY

GLASS...from artisans to automatic machines



4 Today—Modern, electrically driven machines have improved quality, cut costs and increased output in the glass making industry. For example, this unique glass beveling machine, equipped with 7 dynamically balanced Howell Motors, *automatically* bevels glass at the rate of 2,000 inches per hour!

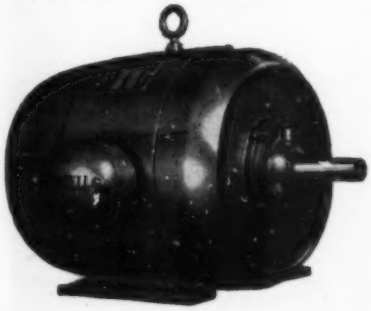
You'll also find precision-built Howell Industrial Type Motors powering bottle and bulb machines, conveyors, grinders, polishers, plate and window machines in the glass industry.

Elsewhere, Howell's wide range of standard NEMA motors, and special motors designed to customer requirements, serve dependably and efficiently under the toughest conditions.

For a really profitable investment, buy HOWELL!

Free enterprise encourages mass production, supplies more jobs—provides more goods for more people at less cost.

Howell totally enclosed, fan-cooled motor—windings completely sealed against dirt and weather.



HOWELL MOTORS

HOWELL ELECTRIC MOTORS CO., HOWELL, MICH.

Precision-built Industrial Motors Since 1915

How to be SURE
When You Specify Springs
When we recommend a spring for a particular job you can be sure it's a sound recommendation. For many, many years we have specialized in designing springs and wire shapes for almost every conceivable type of application. Whether your requirements call for a standard design or a spring specially created for your product, you can count on us to provide the spring that is precisely right.
Would you like a copy of American-Fort Pitt's 28 page handbook of engineering data on springs? It's packed with facts and formulas —and it's yours for the asking.
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SPRINGS

Sewall SPROCKETS
Carried in Stock
or made to order
SEND FOR THE SEWALL CATALOG listing all types of stock sprockets. Sewall roller chain sprockets are available for conveying and power transmission uses. We cut sprockets to order for any type of roller or silent chain. Large and small sizes . . . any material or quantity.
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For Every Need
SEWALL SPROCKETS
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aluminum connection. Similarly it can be used in joining aluminum tubing to copper tubing. Enclosures for sealed devices made of this metal keep the lightweight properties of aluminum without sacrificing the convenience of soft soldering operations which copper provides. Since the copper layer has the same structure and properties as wrought copper, the composite metal can be fabricated from work-hardened rather than from annealed or dead soft material. Where greater strength, or both strength and ductility, are required, high strength aluminum alloys can be substituted for the softer types. The corrosion resistance of the exposed edges is generally satisfactory, but severe conditions may require coatings for protection.

Sheet or strip is supplied in widths up to 6 in. and thicknesses up to $\frac{1}{8}$ in. Tubing is available in diameters up to 1 in.

The copper coating is one-fifth the thickness of the aluminum sheet, but the composite metal can be supplied in other proportions. However, the copper layer should be at least 0.0015 in. thick.

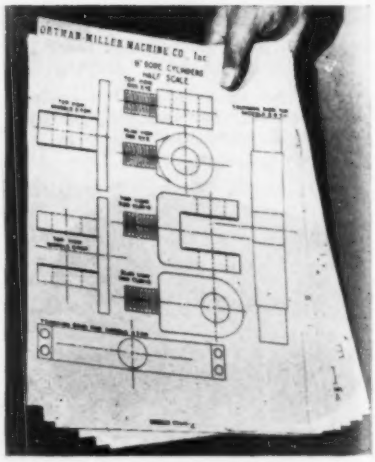
General Plate Div., Metals & Controls Corp., Attleboro, Mass.

Circle No. 38 on Reader Service Card

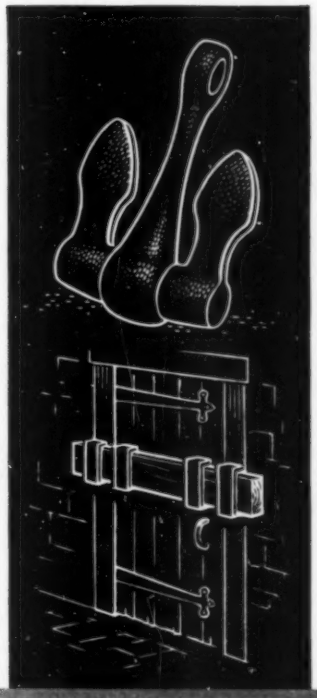
Templates Simplify Design Work

A set of templates covering the manufacturer's line of air and hydraulic cylinders is offered without cost in the belief that design work can be simplified and time saved.

The set, comprising eight sheets printed on both sides, is drawn to both one-half and full scales. Plan, front elevation and end elevation are included on all cylinders from one inch to eight inch bores and a full



An anchor for paint . . .



a bar against rust . . .

BONDERITE belongs

under the finish of fine painted metal products

The enemies of paint begin to work as soon as your product leaves your plant. Moisture, abrasion, scratches and dents injure the paint film and lay the metal bare. The finish on untreated metal will quickly deteriorate.

On Bonderite-treated metal the paint is anchored by the crystalline phosphate coating, integral with the metal. Because it's non-metallic, Bonderite resists rust and corrosion, confines finish damage from scratches to the injury itself. Bonderite-treated products *look better longer.*

Bonderite is the *standard* corrosion resistant paint base. It's used on thousands of painted metal products. Learn how it can help make *your* product better. Write today.

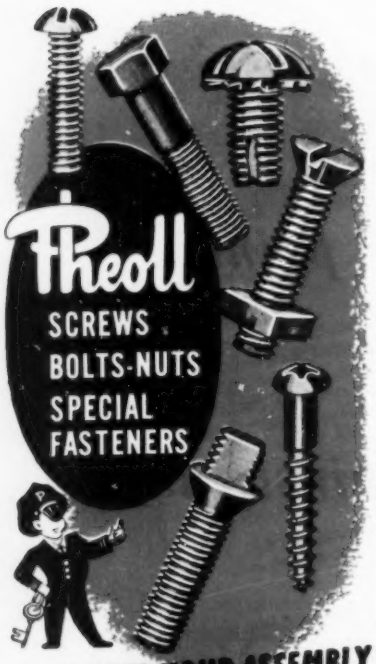
PROTECTED BY Bonderite PARKER RUST PROOF CO. QUALITY CORROSION RESISTANT

Bonderite, Parco, Parco Lubrite—Reg. U.S. Pat. Off.

PARKER

PARKER RUST PROOF COMPANY
2179 East Milwaukee Ave.
Detroit 11, Michigan

BONDERITE—Corrosion Resistant Paint Base • PARCO COMPOUND—Rust Resistant • PARCO LUBRITE—Wear Resistant for Friction Surfaces



WILL KEEP YOUR ASSEMBLY LINES AT PEAK CAPACITY

Whatever you manufacture or assemble, you can speed production and improve your product by using Pheoll screws, bolts and nuts. These industrial fasteners drive easy and straight, and will not bind because threads are accurately rolled or machined. Precision-made screw and bolt heads, slots and head recesses prevent wrench and driver slippage. Count, too, the added bonus you receive by using fasteners that improve product appearance.

An interesting story on standard and special industrial fasteners and their profitable applications to your needs may be obtained from experienced Pheoll engineers. Ask these men to recommend screws, bolts and nuts that will increase your overall profits on assembly line work.

these Pheoll products
prevent production lag
Tapping Screws • Cap Screws • Sems
• Phillips Recessed Head Screws and Bolts
Machine Screws • Special Fasteners
Thread Cutting Screws
Pheoll
MANUFACTURING COMPANY
SCREWS • BOLTS • NUTS

range of interchangeable mounting devices is shown. The templates are slipped in position beneath the designer's tracing paper or cloth and the required component parts (cylinder body plus mounting devices) are traced off.

Ortman-Miller Machine Co., Inc., Hammond, Ind.

Circle No. 39 on Reader Service Card

Outlet Box is Weatherproof

Put on the market recently is a lightweight outlet box which provides five outlet receptables from one inlet. It is said to be weatherproof, waterproof and pull-out proof. Wiring from the inlet to all the outlet receptables is symmetrical. Each outlet will conservatively carry 1,500 w and the inlet receptacle is rated at 6,000 watts, all at 115 v. The circuit is ungrounded to permit use on a-c or d-c and mounting on a grounded or ungrounded metal surface. One-fourth in. diameter mounting holes are provided on each corner of the cast aluminum body. Each receptacle is equipped with a weather and waterproof screw-on cap which is attached to the body by a short chain to prevent loss.

Some of the fields in which it is believed to have application are radio and television, carnivals and other amusement groups, and industrial and home shops.

Equipment and Service Co., 6815 Oriole Dr., Dallas 9, Tex.

Circle No. 40 on Reader Service Card

Gaskets Exclude Moisture, Retain Oil

Introduced as a gasket material for such applications as oil-filled transformers and regulators is a substance called Hycar nitrile rubber which unlike the common gasket materials is not defective, claims the manufacturer, in any of the characteristics of a good gasket material.

Felt is unsatisfactory because of poor oil resistance. With Hycar, oil is permanently retained, and moisture, air, and contamination are sealed out. Although possessing good oil resistance, composition cork and rubber-cork combinations with their relatively high compression set require adhesives for bonding the gasket surfaces to adjacent steel plates. Moreover, rubber cork combinations require adhesives because they possess insufficient resiliency to overcome shrinkage dur-

WORKS WHERE OTHERS WON'T

accurately formed

GRAPHALLOY OILLESS BEARINGS

SPECIFY GRAPHALLOY TRADE MARK REG. U.S. PAT. OFF. WITH CONFIDENCE

SELF-LUBRICATING • EXTREMELY DURABLE • CONSTANT CO-EFFICIENT OF FRICTION • OPERATES DRY — OR *SUBMERGED IN WATER, GASOLINE OR CORROSIVE LIQUIDS* • APPLICABLE OVER A WIDE TEMPERATURE RANGE — *even where oil solidifies or carbonizes* • EXCELLENT AS A CURRENT-CARRYING BEARING.

GRAPHITE METALLIZING CORPORATION

1012 NEPPERHAN AVENUE, YONKERS 3, NEW YORK

ONE OF THE World's Largest Makers of Combines

Selects Gates Engineers

to design V-Belt DRIVES on newest Combine

A Completely V-Belt Driven Combine . . .
Every drive of the most advanced design

In order to reduce the wear and tear of operating his combine, the manufacturer wanted every moving part that was subject to shock to be "cushioned" by the **shock-absorbing** properties of a V-belt Drive—and he wanted to be sure that every V-belt Drive embodied the most advanced engineering design.

He knew that the Gates V-Belt testing laboratories are by far the largest in the world—that Gates runs an average of 32,000 hours of testing every **week** on V-Belts alone! (32,000 hours is equivalent to five years of life for one belt.)

And he knew that Gates hadn't stopped with testing—that Gates Research Engineers had actually reduced the **results** of these tests to **usable data** for the design of every V-belt Drive.

This intensively SPECIALIZED Research has naturally given Gates Engineers a most advanced knowledge of V-Belts and V-Belt Drive Design—and the benefit of this advanced knowledge and experience is available to **you, right in your own plant, any time you want it!**

Whether you have a difficult drive to design—whether some V-Belt drive in your plant is giving trouble—or whether you merely want to know what size and construction of V-Belts will give the most efficient and the lowest cost service on a particular drive—you have only to phone a Gates Engineer.

Actually, **there are more than a dozen GATES V-BELT DRIVES on this One Combine!**

Some of them you can't see, no matter what view of the Combine is given. Every one of these drives had to be of the most advanced engineering design to insure superior service.

Gates Eng-509

The Mark of SPECIALIZED Research

There is always a Gates Field Engineer near you in all industrial centers. Just look in your phone book under "Gates Rubber." He will come to you promptly—and he will put at your service the full benefits of Gates unrivaled V-belt knowledge and experience **without the slightest obligation!**

THE GATES RUBBER COMPANY
The World's Largest Makers of V-Belts.
DENVER, U. S. A.

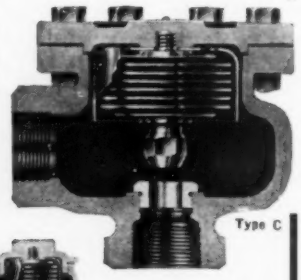
GATES VULCO ROPE DRIVES
Engineering Offices and Jobber Stocks **IN ALL INDUSTRIAL CENTERS** of the U. S. and 71 Foreign Countries

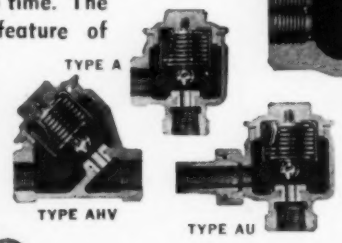
Nicholson Makes

Freeze-Proof Steam Traps

for Every Plant Use

Because they drain completely when cold, these four types of Nicholson steam traps are positively freeze-proof. Can be freely installed outdoors. Universally recommended for use in lines which need not be in continuous use during cold weather, because they are freeze-proof and because their 2 to 6 times average drainage capacity results in minimum heat-up time. The non-air-binding feature of Nicholson traps also notably facilitates steam transfer in severe weather.





Four types: size ¼" to 2"; press. to 225 lbs. BULLETIN 450.

HIGH-PRESSURE FLOATS—Stainless, monel, steel or plated steel. Welded. In all sizes and shapes; for operating mechanisms and as tanks or vessels. 2-day delivery. BULLETIN 650.

W. H. NICHOLSON & CO., 200 Oregon St., Wilkes-Barre, Pa.

O-RINGS

by INJECTION MOLDING

Dependable Hydraulic Seals

Minnesota O-Rings function in air or gas systems as well as in hydraulic systems. Air cylinders . . . hydraulic valves . . . hoisting mechanisms . . . water pumps . . . bottling machines . . . refrigerators . . . motors . . . lubricators . . . are a few of their uses. Minnesota's exclusive injection process makes possible very close dimensions, uniformity in mass production and downright economy. We use special compounds of synthetic rubber to meet your exact requirements. Let us make a quotation on your next hydraulic packing installation.

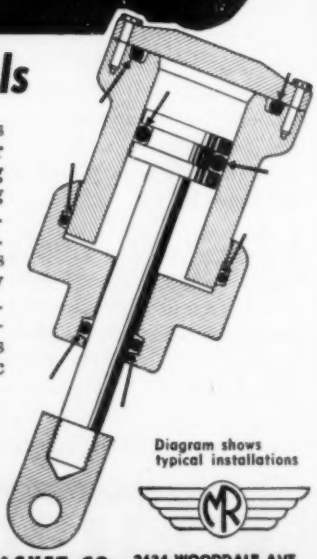


Diagram shows typical installations

Manufacturers of all types of small rubber parts

Write for O-Ring Catalog

MINNESOTA RUBBER & GASKET CO. 3634 WOODDALE AVE. MINNEAPOLIS 16, MINN.

ing changes in temperature. Hycar gaskets do not require adhesives and consequently less time is required for their assembly. Moreover, this factor makes them usable again whereas fresh cork composition or cork-rubber combination gaskets cannot be used more than once.

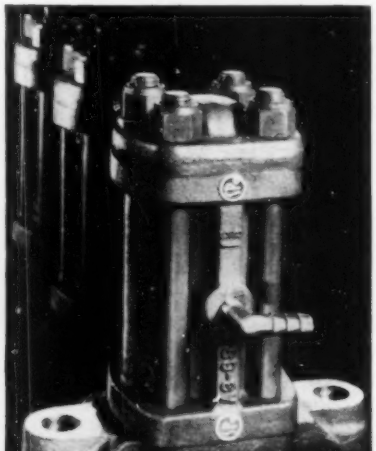
B. F. Goodrich Chemical Co., 324 Rose Bldg., Cleveland 15, Ohio

Circle No. 41 on Reader Service Card

Pneumatic Vibrators Shake Bins

Vibrators have been designed for intermittent or continuous operation on all types and sizes of storage bins, hoppers, and chutes handling sand, cement, lime, coal, ore, grain, slag, and chips as well as other powdered or granular materials.

Designed to deliver hammer-like



impacts in a direction 90 deg to material flow, the vibrators prevent the contents of bins or hoppers from arching-over or plugging and assure a steady flow through chutes.

A special, corrosion-proof, bronze alloy cylinder line is utilized to assure full-power start, high-speed operation, and maximum service life. In addition, these powerful units have a sturdy, cast semi-steel body and cast steel mounting plate. Four alloy-steel bolts and lock nuts are used for positive unit assembly. Vertical construction permits mounting in any desired position with no loss of operating efficiency.

For hopper installations, the vibrators can be used in conjunction with a hopper-gate valve, which actuates the vibrator only when the hopper discharge gate is open. This type of controlled operation prevents acci-

Parker-Kalon GROUND THREAD Socket Set Screws

SET RIGHT with SHOP MEN

RIGHT START

Quick starting, they speed assembly work and improve production.

RIGHT FINISH

Made from hardened stock, they have the smoothness of a true ground finish.

RIGHT FIT

Free from nicks, burrs and tool marks, they give you a dependable Class 3 Fit.

RIGHT BUY

More for the money—in quality—in performance—when you use P-K® Quality Controlled Socket Set Screws.

SEE FOR YOURSELF!

Send for Samples. Feel the difference thread grinding makes. Check the uniform Class 3 Fit. Notice how much smoother (and easier starting) Parker-Kalon Socket Screws are, the way they "set up" to dependable security. Once you try 'em, you'll use them regularly—to speed your assembly work. Write for samples today. Parker-Kalon Corporation, 200 Varick St., New York 14, N. Y.

®TRADE MARKS REG. U.S. PAT. OFF.

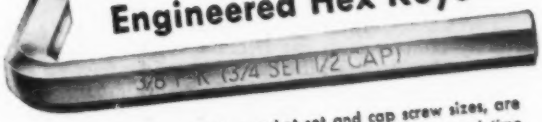
P-K TRADE MARK

PARKER-KALON®

cold-forged

SOCKET SCREWS

NEW... Size-marked Engineered Hex Keys

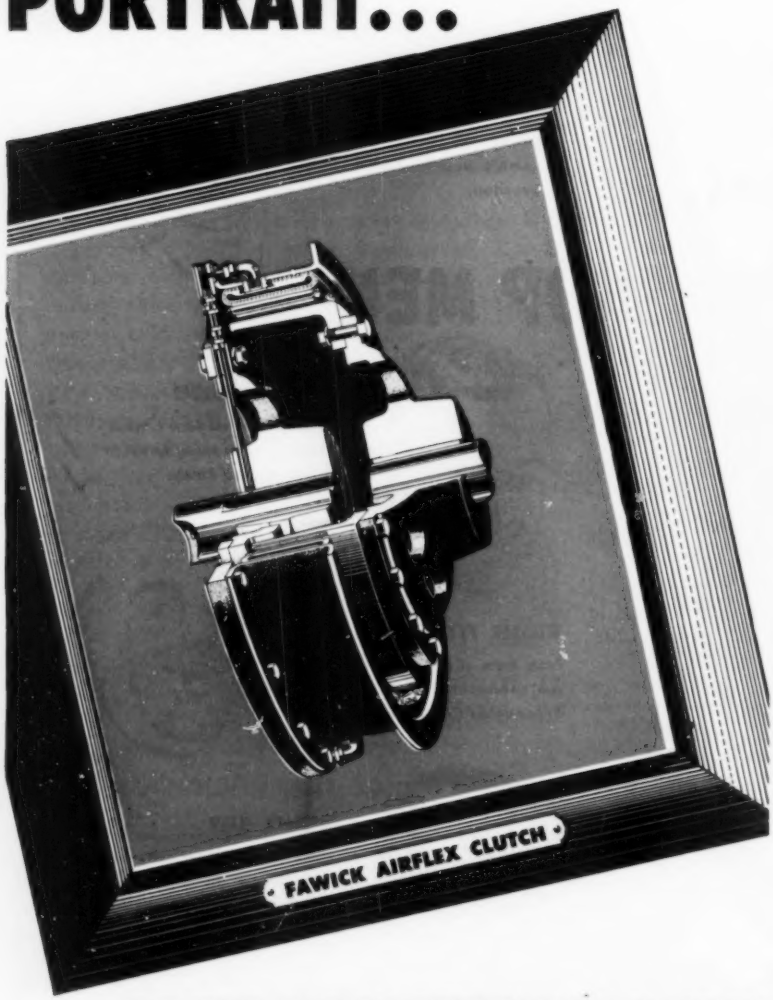


Key size, and corresponding socket set and cap screw sizes, are clearly stamped on arm of key. Eliminates guesswork and time wasted selecting the right key. The Size-Mark is especially useful in training new help.

➔ Parker-Kalon Engineered Hex Keys are again available in an attractive, compact steel case with easy-to-use key island (Set No. 111). Also available in a compact and durable plastic pouch (Set No. 45).

SIZE-MARKED SOCKET HEAD CAP SCREWS • GROUND THREAD SOCKET SET SCREWS • FLAT HEAD SOCKET CAP SCREWS • STRIPPER BOLTS • PIPE PLUGS • HEX KEYS • *AVAILABLE THROUGH ACCREDITED DISTRIBUTORS*

PORTRAIT...



OF THE MOST EFFICIENT CLUTCH SERVING INDUSTRY...

Claims and counterclaims are constantly being made as to the relative efficiency of industrial clutches of all types.

If your industrial clutch problem can best be solved with an air clutch, investigate Fawick Airflex Clutches.

Fawick and only Fawick provides users with (1) 360° constant-velocity contact with the friction surface, (2) uniform-pressure axial contact between the full width of the friction surface and the drum, (3) unrestricted shock absorbing flexibility of the torque-transmitting rubber tube, (4) complete and sensitive torque remote control.

For specific information on all advantages of Fawick Industrial Clutch and Brake Units, write to the Main Office, Cleveland, Ohio, for Bulletin 300.

All desirable clutch characteristics are built into Fawick Airflex units

FAWICK Airflex CO., INC.
9919 CLINTON ROAD CLEVELAND 11, OHIO

FAWICK CLUTCHES = + + + = PEAK EFFICIENCY

dental packing of hopper contents by premature vibration, conserves air power, and provides for maximum efficient service life.

Vibrators are available in $1\frac{5}{8}$, 2, and $2\frac{1}{2}$ in. piston diameter sizes, and units are equipped with a $\frac{1}{4}$ in. rigid or swivel type straight or ell connector for hose attachment.

SPO, Inc., 6554 Grand Division Ave., Cleveland 5, Ohio

Circle No. 42 on Reader Service Card

Instrument Compares Surface Finishes

A precision surface finish comparator is used for the comparison of surface finish or surface roughness on flat or curved surfaces having a diameter greater than $3\frac{3}{4}$ in. where the surface roughness ranges from 30 to 500 micro-inches rms. The instrument does not give a direct micro-inch rms reading, but shows a reading which is actually a measurement of the escapement of air over a circle of approximately $\frac{1}{8}$ in. in diameter.

There is an important advantage in measuring surface finish over an area instead of on a line, especially when determining the quality of finish of a bearing surface. For example, it is possible for a sawtooth surface to give much the same reading on an rms line measuring instrument as a relatively smooth surface in which there are a few deep scratches. With the comparator the latter surface would actually be indicated as a good bearing surface. But a sawtooth surface would be revealed as unsatisfactory for bearings.

The present model will give repetitive readings in the comparison of surface finishes, one finish with another or with a selected standard. It can also be used in establishing readings on surfaces to be used as standards. Any number of readings may be taken in quick succession, as rapidly as the gaging head can be manually presented to the work. No special skill or operator training are claimed to be necessary. It requires little bench room, approximately 6 by 6 in., and is designed for use in the shop as well as in the laboratory. The comparator is supplied complete with right-hand scale, 20 to 110 micro-inches; left-hand scale, graduations in black, 100 to 300 micro-inches; graduations in red, 300 to 500 micro-inches. The instrument may be attached to any plant air supply line or air compressor supply.

Sheffield Corp., Dayton 1, Ohio

Circle No. 43 on Reader Service Card

NOW RESISTANCE SPOT WELDING

(TO AN-W SPECIFICATIONS)

WITH this one welder you can weld the widely divergent metals listed above simply by changing control settings. Designed to weld aluminum to Army and Navy specifications, its ability to handle a wider range of thicknesses permits welding many aircraft components including primary structural members. Because it welds faster and will handle a wider range of work than any previous resistance welders, it produces at lower cost and can be amortized more quickly. Quality of welds is unsurpassed.

The patented Sciaky Three-Phase System uses up to 75% less current than single-phase welders and operates at approximately 85% power factor, making it practical even where power facilities are limited. Write for details today.

SCIAKY BROS., INC.
4913 W. 67th St.
Chicago 38, Illinois

SCIAKY
SAY "SEE-ACKY"

NEW SCIAKY SERIES PMCO2ST Three-Phase Modu-Wave Welder

100 KVA at 50% duty cycle
220 and 440 volt 3-phase, 60 cycle*
Standard Throat depth 36"

Welding Range to AN-W specifications (2 thicknesses): aluminum and magnesium alloys .025" to .081"; stainless steel .022" to .109"; low carbon steel .022" to .156".

* Available with special controls for 25 and 50 cycle.

SEND FOR BULLETIN

Complete details, description of controls, features, specifications are included in Bulletin 134-ST. SEND FOR YOUR COPY TODAY.

WHAT material would you choose?

1. CHEMICAL FEED TANK: Part of control unit in commercial cleansing machine handles sodium hypochlorite, acetic acid, hydrofluoric acid, with fumes so corrosive they attack stainless steel. What economical, corrosion-resistant molding material is widely used for problems like this?

2. SODA WATER TUMBLER, small part for soft drink dispenser. Must be odorless, tasteless, unaffected by syrups, with low moisture absorption. Should provide tight fluid seal, with excellent dimensional stability. Tough production problem, too, in angle holes. How would you tackle this?

Answers: No. 1—Molded Ace Hard Rubber keeps corrosive solutions in their place, may solve your corrosion problems too. No. 2—Again Ace Hard Rubber was ideal. Small holes were drilled after molding this part.

Sometimes it's hard rubber—and sometimes it's one of the other plastics that's best. Ace, with many hard rubber and plastics compounds to choose from, is fully equipped to supply whatever you need. If you want this kind of impartial advice from your molder, select American Hard Rubber Company.

Ask for ACE Handbook

ACE
Since 1851
HARD RUBBER and PLASTICS
AMERICAN HARD RUBBER COMPANY
11 MERCER STREET • NEW YORK 13, N. Y.

OUR READERS SAY

More on Spring Design

To the Editor:

In your May 1950 issue, on page 205, Mr. O. Meyer states that in designing springs, a safety factor of 1.5 is adequate. I believe that such a low value does not give any assurance that the elastic limit will not be exceeded thus resulting in permanent deformation. A factor of this low magnitude might be satisfactory for springs having limited service as in electric switches, doors and absorbers.

Since the modulus of elasticity of steel is affected by elevated temperatures, this should be also considered in applications where high temperatures are encountered. In this respect, I have some data which might be of interest:

Temperature, F	62	200	390	575	750
Reduction in Modulus, percent	0	2	5	9	15

—VICTOR TATARINOV
Pilsen, Czechoslovakia

Community Chest Support

To the Editor:

Please accept our warmest thanks for the fine way you have supported the Community Chest campaigns in your October issue of PRODUCT ENGINEERING. We particularly liked the way you set up the statement by the two Wilsons, and we also liked the attractive Red Feather on your masthead page. —MARY K. DABNEY
Community Chests and Councils of America, Inc.

Tolerances Rear Their Ugly Heads

To the Editor:

I was interested in reading Mr. Thomas L. Lane's dissertation, Dimensioning Parts for Economical Production, in the October issue of PRODUCT ENGINEERING.

I agree with Mr. Lane that dimensions should be simple and that they should be put on drawings in a manner such that the part can be most easily made. It is, however, necessary that the parts be made so that they function properly, and this necessitates

Photo Courtesy of Goodyear Tire & Rubber Company

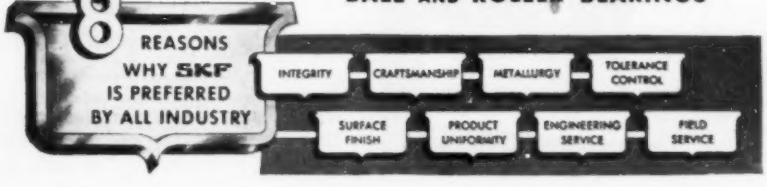
RIVER-GOING VACUUM CLEANER

...*bearings by* SKF

It takes constant dredging to keep the Sacramento and San Joaquin Rivers open for navigation. But the *William E. Palmer*, owned by the Olympian Dredging Company, has done a superman job of it, day in and day out. The gear box and driving motor for the cutter shaft are both SKF-equipped with Spherical Roller Bearings . . . bearings that tackle and handle successfully any job where the going's rugged. That's because extra stamina is built into every SKF Bearing. It's the direct result of SKF pioneering . . . of SKF's program of continuing research . . . of SKF engineering skill in putting the right bearing in the right place. When you look for trouble-free service . . . long life . . . complete dependability . . . unvarying quality . . . look to SKF. *SKF Industries, Inc., Philadelphia 32, Pa., the Pioneers of the Deep Groove Ball Bearing—Spherical Roller Bearing—Self-Aligning Ball Bearing.* 7074

SKF

BALL AND ROLLER BEARINGS



BUILDING SERVICE REPUTATIONS

While Creating Savings

FOR PRIMARY EQUIPMENT MAKERS

WHS

WINSMITH

SPEED REDUCERS

Management's penetrating interest in components of prime products goes deep . . . down to the last nut and bolt, as service reputation often hinges on individual parts, even those of outside manufacture. For the customer, failure of *any* part of the machine, regardless of cause or make, is a black mark against the *entire* product.

Vigilantly alert to this, the design engineer, the production manager, the purchasing agent, yes, even the sales manager—all concerned with the performance and marketability of primary equipment —are especially discerning in the selection of power transmission components.

Here you have one of the principal reasons that Winsmith Speed Reducers are so frequently selected . . . a preference based on enduring performance, the vital asset that means protection of a prime product's service reputation.

But you pay no premium for this protection. Actually, you save! For within the power range of fractional to 85 H.P., Winsmith has fully standardized on the widest selection of speed reducers in the industry . . . to serve you speedily and most economically.

Match *your* product's high reputation with components fabricated with the same care, backed by the same high reputation, that no link in your service chain may be weak. Winsmith power transmission engineers welcome the opportunity to consult. Write.

MEMBER OF AGMA

WINFIELD H. SMITH CORP.
111 EATON ST.
SPRINGVILLE (Erie County), N. Y.

FREE Catalog Handbook No. 148 with complete engineering data. Write.

tolerances being placed upon drawings. Mr. Lane does not go into that phase of dimensioning. Suppose that in his Figure 3(A) the important dimensions were "D" and that the allowable tolerance were ±0.002. Let's also assume that the permissible tolerance on "A", "B", and "C" were ±0.010. If the part were then dimensioned as shown in his Figure 3(B), the tolerance on "A" and "B" in that figure would have to be ±0.001. That might increase manufacturing costs. It is questionable in my mind, therefore, whether 3(B) is the proper dimensioning scheme in this particular case.

This is not a plea for closer tolerances or for more complicated drawings, but I am convinced that we cannot tell what the best method of dimensioning is unless the tolerances on the various dimensions are known.

—FERDINAND JEHLE
Hoffman Specialty Company

Ed—You are perfectly correct in your discussion of the tolerance phase of dimensioning. As indicated, only too frequently unnecessarily close tolerances lead to higher costs.

A Screw Was Missing

To the Editor:

We were very much interested in reading the article, "Look to Quicker Methods of Fastening and Joining", which appeared on pages 118-119 of the June 1950 PRODUCT ENGINEERING. In illustrating this article at the bottom of these pages, you did not show the multiple-spline socket screw manufactured by the Bristol Company. This screw is an important factor in fastening parts of machines and appliances. It is widely used by manufacturers of equipment such as adding machines and x-ray machines. For the reason that it is an important fastening device, from the standpoint of the design engineer, we feel that this should have been included in your article.

—G. P. LONERGAN
The Bristol Company

Ed—The multiple-spline socket screw is definitely an important member of the fastener family. We agree with Mr. Lonergan and regret this omission.

New Plastics Interest Germans

To the Editor:

As readers of your various publications, we should appreciate receiving information from you on new plas-

CONSULT THESE EXPERIENCED FABRICATORS OF ROYALITE

CALIFORNIA
Artisan Engineering & Mfg. Co., Inc., 5037 W. Jefferson Blvd., Los Angeles 16
Horace L. Blackman Co., 287 So. Robertson Blvd., Beverly Hills
C. K. Castaing Studio, 17862 S. Huntington Beach Blvd., Huntington Beach
Engineering Plastics Co., 1475 El Mirador Dr., Pasadena 3
Schoen-Burn, 1646 Gough St., San Francisco 9
Swedlow Plastics Co., 5527 District Blvd., Los Angeles 22
Technical Reproductions, 5526 Cleon St., N. Hollywood

COLORADO
Pikes Peak Plastic, 5 W. Cucharras St., Colorado Springs
Plasticraft Co., 2806 N. Speer Blvd., Denver

CONNECTICUT
Colt's Mfg., Hartford 15

GEORGIA
Gladwin Plastics, 542 Courtland St. N.E., Atlanta

ILLINOIS
Arrem Plastic, 1539 N. Throop St., Chicago 22
Associated Plastics Fabricators, 164 N. May St., Chicago 7
G. Felsenthal & Sons, 4100-4118 W. Grand Ave., Chicago 51
Lamicoid Fabricators Inc., 4545 W. Cortland St., Chicago 39
Neo Products Co., 2534-38 S. Kedzie Ave., Chicago 23
Precision Plastic Products Inc., 628 W. Lake St., Chicago 6

INDIANA
General Plastics Corp., 1400 N. Washington, Marion

MARYLAND
Fawn Plastics Co., 2902 Hamilton Ave., Baltimore 14

MASSACHUSETTS
Koehler Mfg. Co., Marlboro

MICHIGAN
Cadillac Plastic Co., 651 W. Baltimore, Detroit 2
Imperial Industries, 4435 Walker Ave., Wayne
Klise Mfg. Co., 50 Cottage Grove S.W., Grand Rapids 2
Plasticle Corp., 4207 Grand River Ave., Detroit 8
Reynolds Plastics, Inc., 3445 W. Forth St., Detroit
Unique Creations, Inc., 1349 East Milwaukee, Detroit 11
Woodall Industries Inc., 7565 E. McNichols Rd., Detroit 34

MINNESOTA
T. O. Plastics, 58th & Longfellow, Minneapolis
Plastics, Inc., Chestnut & Ryan Sts., St. Paul 2

MISSOURI
Regal Plastics Co., 710 Main St., Kansas City

NEBRASKA
Omaha Plastics Co., 1470 S. 16th St., Omaha 9

NEW JERSEY
Sillcocks-Miller Co., 10 W. Parker Ave., Maplewood
Stokes Molded Products, Inc., Taylor St. at Webster, Trenton 4
Thermacote Co., 320 Jefferson St., Newark 5
Van Beek Industries, 23 Park St., Orange

NEW YORK
Bassons Molded Products, 1424 W. Farms Rd., New York 60
Curbell Inc., 1700 Elmwood Ave., Buffalo 7
Dual Fabricators Corp., 808 Driggs Ave., Brooklyn 11
Dura Plastics Inc., 1 W. 34th St., New York 1
Durable Formed Products, Inc., 329 Canal St., New York 13
Mastercraft Plastics Co., Inc., 95-32 150th St., Jamaica 4
Steiner Plastics Mfg. Co., 47-30 33rd St., Long Island City 1

OHIO
Fabri-Form Co., Box 36, Cambridge

PENNSYLVANIA
Lee Plastics, A and Lippincott St., Philadelphia 34
Halsen Mfg. Co., 5919 Webster St., Philadelphia

TENNESSEE
Plasti-Line, Inc., Jacksboro & Broadway, Knoxville 18

TEXAS
Plastic Engineering Co., 2101 69th St., Houston 11
Plastic Products of Texas, 3319 Love Field Dr., Dallas

WASHINGTON
American Plastics, Inc., 905 Western Ave., Seattle
K. B. Plastics, Inc., 1817 So. 1st St., Yakima

WISCONSIN
Midland Plastics Inc., 227 N. Water St., Milwaukee 2

The United States Rubber Company at 2638 North Pulaski Road, Chicago, Illinois, has complete Engineering, Designing, and Styling Departments to assist fabricators on the technique to employ, and in the art of fabricating most efficiently with ROYALITE.

tics in your country. We learned from one of your books that new developments are being made which will surely be of interest to us. For your information, we should like to point out that we are manufacturers of vacuum cleaners with plastic casings. Our problem arises from the fact that most of the usual plastics are not sufficiently shock- and knock-proof.

We trust that you are in a position to furnish us with information concerning these new developments and also to give us the names of some firms who might be able to supply us with these plastics. —VORWERK & CO.
Wuppertal-Barman
Germany

Ed—Two special articles on plastics which were prepared by one of our editors have appeared in recent issues of PRODUCT ENGINEERING. These are "Plastics As Engineering Materials" which was in the September 1948 issue and "Recent Developments in Plastics and Rubber" which was in the April 1947 issue.

As for your particular problem in vacuum cleaners, it is assumed that you are referring to the sweeper housing. Most American manufacturers of upright vacuum cleaners are using a molded cellulose acetate plastic housing. Manufacturers of cellulose acetate plastic materials in this country are: Celanese Corporation of America, 180 Madison Avenue, New York 16, New York; Hercules Powder Company, Plastics Division, Wilmington, Delaware; and Tennessee Eastman Corporation, Kingsport, Tennessee.

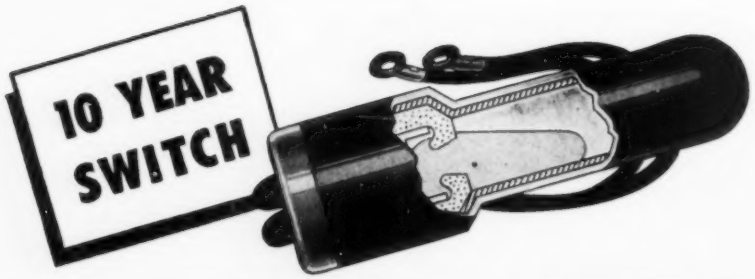
Foundrymen Down Under

To the Editor:

We are subscribers to your excellent magazine, PRODUCT ENGINEERING, and we would like to ask your help in obtaining some information to help us overcome some of the problems we have in our industry.

We are founders in non-ferrous metals specializing in permanent mold methods, and we would like to find out any information relative to permanent mold casting in bronze and aluminum bronze alloys.

Can you get any manufacturer in your country to supply us with information the best type of furnace, firing, and exhaust of the flue gases, or any articles that may have appeared dealing with this subject in relation to die design and production methods? This industry in Australia is in its infancy and the data obtainable here are very limited. We are taking



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WRITE FOR CATALOG 49F

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this opportunity of trying to increase our knowledge of this subject with your help. —L. H. GREEN
Castalloy Ltd.
Adelaide, S. Australia

Ed—It is good to know that PRODUCT ENGINEERING is so well liked in Australia.

Two articles have been published in PRODUCT ENGINEERING which include the subject of permanent mold casting in bronze and aluminum bronze alloys. One is "What's Ahead in Metals" which begins on page 87 in the October issue. The information you desire can be found on page 94. The other is "Centrifugal Castings in Permanent Molds" which appears on page 112 in the November issue.

It is suggested that you write to the organization listed below for further technical information. Non-Ferrous Founder's Association, 111 West Washington St., Chicago, Illinois; American Foundrymen's Association, 222 West Adams St., Chicago 6, Illinois; Non-Ferrous Founder's Society, 127 N. Dearborn St., Chicago, Illinois; Aluminum Industries, Inc., Keller and Beekman Streets, Cincinnati 25, Ohio; Aurora Metal Company, Thurnauer and Lander Streets, Aurora, Illinois; and Wellman Bronze & Aluminum Company, 2525 East 93rd St., Cleveland, Ohio.

Where Can I Get It?

Armature Winding in America

To the Editor:

When, some years ago, we became subscribers to your very enlightening publication, we were informed of a service of which we could avail ourselves concerning the publication of new ideas from America and elsewhere. When we gave our order for your publication, we were told that all we had to do was to write to you requesting the latest information on a certain production problem and that within a few days we should receive from you the fullest details of the latest methods employed in this particular line. Well, this is our problem.

We wish to purchase a machine which is capable of winding, as automatically as possible, small electric motor armatures with cores approximately 1 in. to 2 in. in dia and 1 in. to 2 in. in length with wire which is between 21 and 32 gauge in diameter. The information we require consists of the answers to two questions. What

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● With clearances in modern machines measured in thousandths, not fractions, protection against major damage due to unavoidable mis-alignment is an essential safeguard to expensive working parts.

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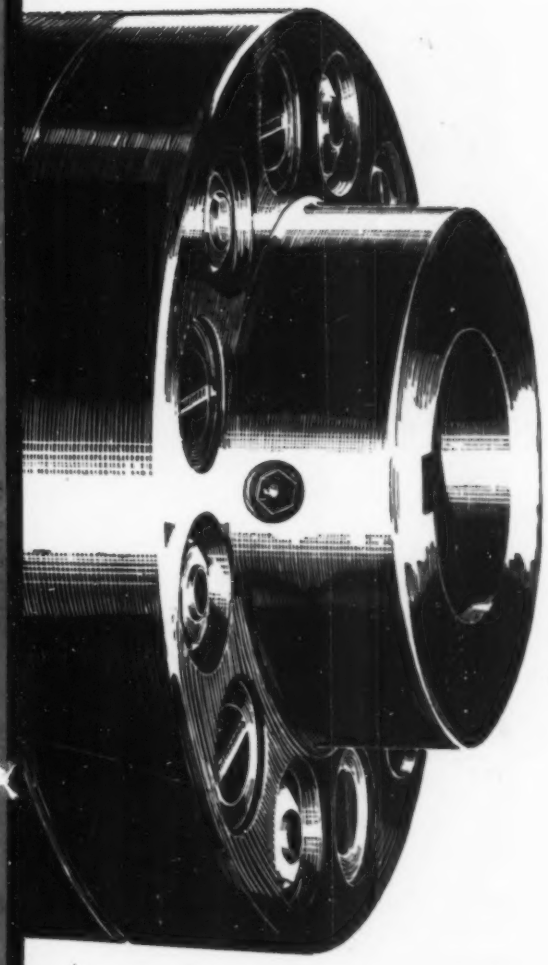
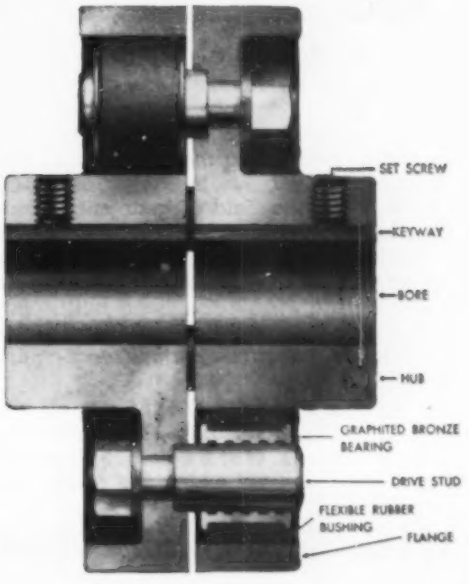
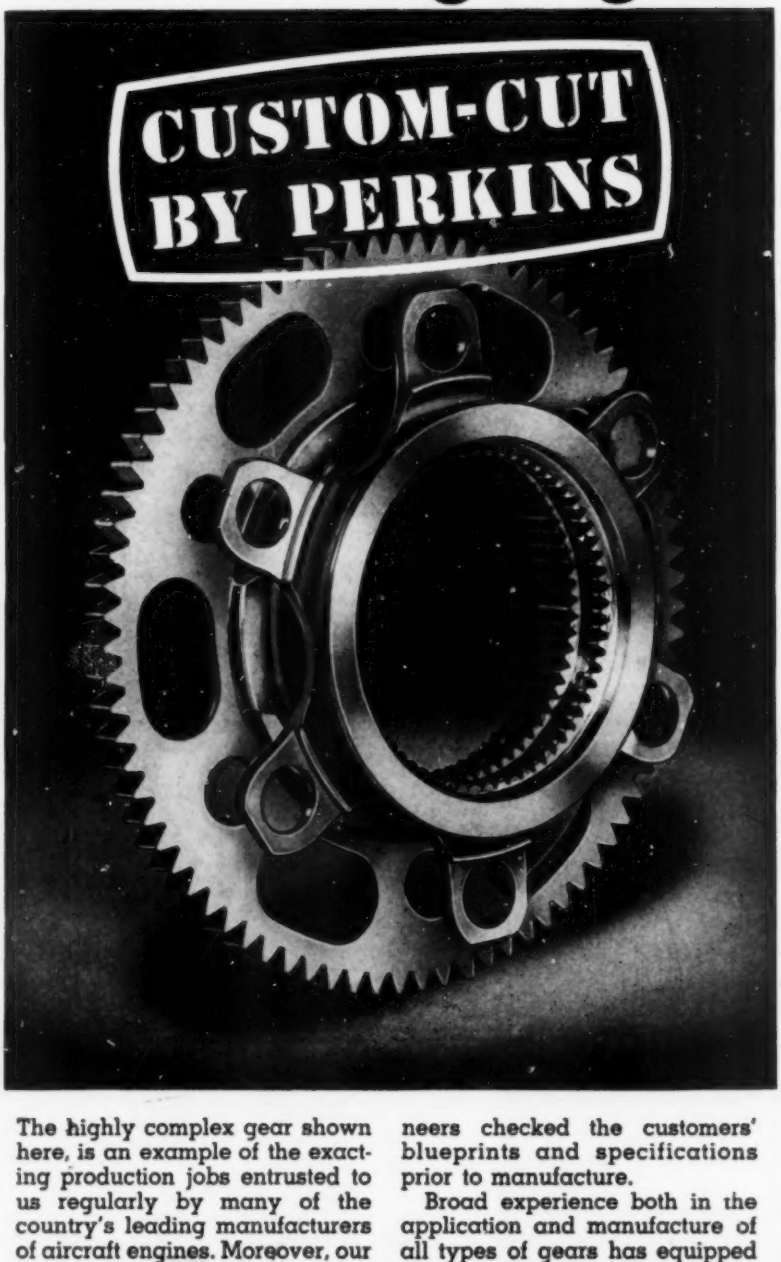




Write for Catalog.

AJAX FLEXIBLE COUPLING CO. INC.
72 English St., Westfield, N. Y.

AIRCRAFT engine gears



The highly complex gear shown here, is an example of the exacting production jobs entrusted to us regularly by many of the country's leading manufacturers of aircraft engines. Moreover, our ability in the field of gear engineering extends into practically every industry. Thus a vast amount of *all* types of equipment in use right now has been built at less cost and operates more efficiently because Perkins' engineers checked the customers' blueprints and specifications prior to manufacture.

Broad experience both in the application and manufacture of all types of gears has equipped our staff to bring to your project a highly specialized knowledge of power transmission problems.

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are the latest methods of armature winding and impregnation in America? From whom can we purchase the latest and most up to date armature winding machines? L. L. LLOYD
Lancing Electrical Mfg. Co. Ltd.
Sussex, England

Ed—We were indeed pleased to find that our representative who sold you the original subscription to PRODUCT ENGINEERING informed you that we could give you information on anything. We wish that were so. However, perhaps we can help you out on this particular request—methods of armature winding and armature impregnation.

The Bodine Electric Company, 2254 West Ohio Street, Chicago 12, Illinois (Mr. H. C. Bodine, Chief Engineer) has a new armature winding machine in development, and it is likely that it is now being marketed. A letter to them would probably bring some specific suggestions as to types of equipment available and the people from whom they can be obtained.

The Westinghouse Electric Corporation has a very advanced type of machine in operation in their East Springfield, Massachusetts plant. It is suggested that you contact Mr. Carpenter at the East Springfield plant who was the original designer.

There are other concerns that you might contact. The International Products & Manufacturing Co., 1454 So. Michigan Avenue, Chicago, Illinois is a manufacturer of automotive armature winding machinery. Ideal Industries, Inc., 1006 Park Avenue, Sycamore, Illinois, manufactures a coil winder machine that has an armature winding head for small armatures and an armature winding yoke for medium size armatures. Globe Tool and Engineering Company, 400 Davis Avenue, Dayton 3, Ohio, makes semi-automatic winders.

Expanding and Contracting Fiber

To the Editor:

We are desirous of obtaining information as to where we can procure a fiber or organic compound having the property of expansion when immersed in water and of contraction when removed from water. The names of the concerns that might be able to supply such materials will be very much appreciated.

—J. C. MYERS, JR.
Radiator Valve Co. of America

Ed—It is a little difficult to give a specific answer. The two companies

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This was no accident. The customer's equipment, together with the number and extent of draws, were carefully considered. Then a brass alloy of suitable composition and temper was supplied. Results were evident immediately.

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The Ross Sprinkler Company of Pasadena, California, in business since 1904, manufactures a broad line of Lawn Sprinkling Equipment and Air Conditioning Nozzles. Topmost illustration is full size; others indicate the extent of deep drawing required in producing the Ross No. 10 Solid Brass Hand Sprinkler.

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Patented Flexible Disc Rings of special steel transmit the power and provide for misalignment and end float.

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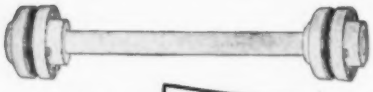
Specialists on Couplings for more than 30 years



BACKLASH FRICTION WEAR and CROSS-PULL are eliminated
Lubrication is not required!

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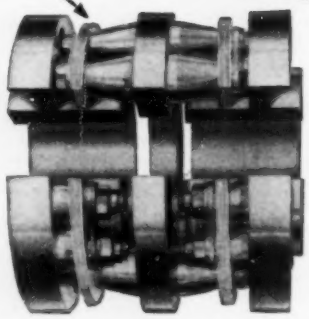

THE THOMAS PRINCIPLE GUARANTEES PERFECT BALANCE UNDER ALL CONDITIONS OF MISALIGNMENT.
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ALL PARTS ARE SOLIDLY BOLTED TOGETHER.

Write for the latest reprint of our Engineering Catalog.

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that come to mind are Continental Diamond Fibre Company, Newark 45, Delaware, and Synthane Corporation, 24 River Road, Oaks, Pennsylvania, with which it is affiliated. In addition, the Armstrong Cork Company, Lancaster, Pennsylvania is an equally good source.

If the problem is one of sealing or of a valve seat, it is suggested that contact be made with National Motor Bearing Company, Redwood City, California, and The Chicago Rawhide Company, 1299 Elston Avenue, Chicago 22, Illinois.

Special Cutting Machines

To the Editor:

We are subscribers to your magazine and in our capacity as such take the liberty of asking you whether in the United States of America there exists a machine that could cut open, lengthwise, an electrical cable in such a way that the wire would be stripped of its insulation; also a machine that could cut up pipes and tubes. This machine should work not with saw-blades nor grinding disks but with smooth knife-blades. We are informed that a machine of the latter type is being built by the Quijada Tool Company, Los Angeles, California.

We would be only too glad if you would send us catalogs, illustrated literature and prices for such machines.

EYRING & SCHEELKE
Hamburg-Altona, Germany

Ed—Inquiries are being addressed to Quijada Tool Company and other firms in an effort to make the requested information available.

Phosphate Lubricant

To the Editor:

In this article, "What's Ahead in Metals", appearing in the October issue of PRODUCT ENGINEERING, mention is made of the use of a crystalline metal phosphate coating applied to cold extrusion punches and dies to provide a durable lubricant film.

We will appreciate having you refer us to the proper source from whom we can obtain additional information on the preparation and use of such a coating. —P. J. CHAUSSY
E. I. du Pont de Nemours & Co.

Ed—Either the Parker Rust-Proof Company, 2169 E. Milwaukee Avenue, Detroit 11, Michigan or the Pennsylvania Salt Manufacturing Company, 49 Lea, Whitemarsh, Philadelphia, Pennsylvania, can help you.

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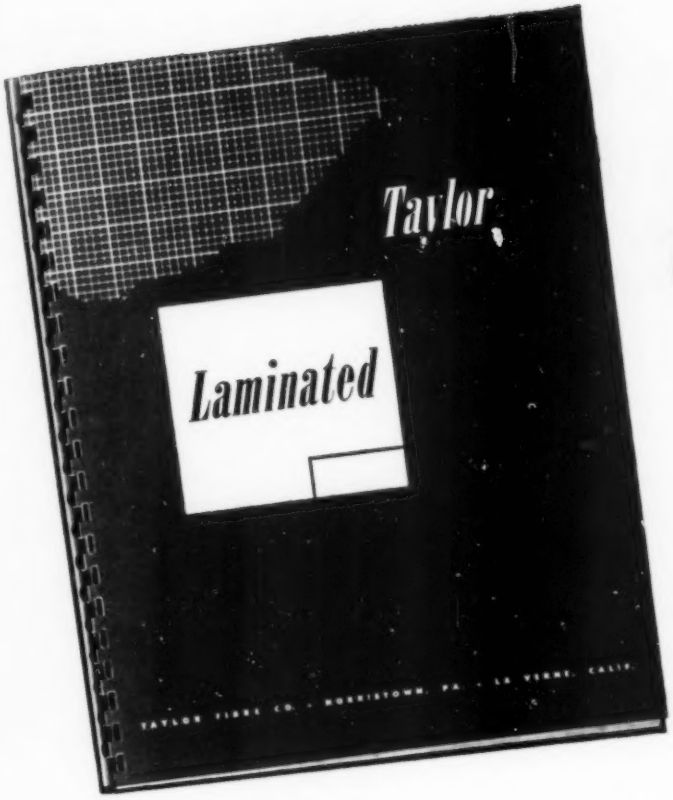

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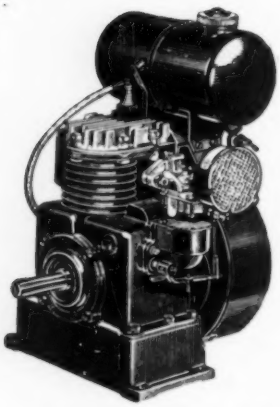

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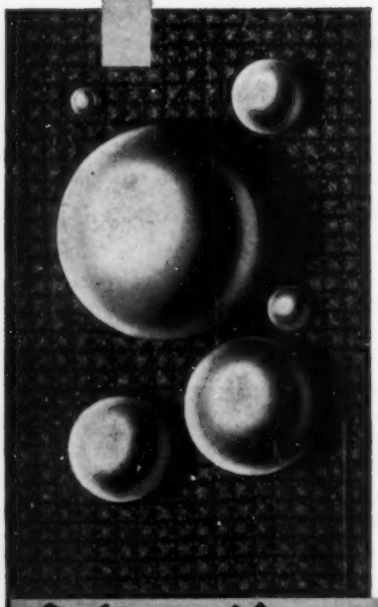

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NEW BOOKS

Symposium on Application of Statistics

Presented at the First Pacific Area National Meeting of the American Society for Testing Materials. 6 x 9 *in,* 36 *pages. Published by the American Society for Testing Materials,* 1916 *Race St., Philadelphia* 3, *Pa.* $1.

Quality control is the effort made to insure that the quality of the goods being shipped to a customer meets established standards which are economically sound. Included in this symposium are three papers which emphasize the importance of the application of statistics to quality control in modern testing.

The Economic Relationship between Design and Acceptance Specification by Eugene L. Grant, Professor of Economics of Engineering, Stanford University is the first paper. The author's thesis is that the setting of the design specifications and of the acceptance specifications should be viewed as two parts of a single problem of economy. This problem of economy, however, cannot be solved without the point of view and the techniques of statistical method. After outlining the costs which are influenced by both sets of specifications, the discussion of the subject matter continues with the effects caused by changing a specification. Examples illustrate the points made. Comments on the paper conclude the discussion.

Precision and Accuracy of Test Methods by Grant Wernimont, Eastman Kodak Co. is the second paper. Since A. S. T. M. Committees make use of data obtained by the use of physical or chemical test methods, it is important to know something about the reliability, the precision and the accuracy of these test methods. The author's purpose is to show how statistical techniques can be used to study and evaluate these three attributes. In the discussion which follows, he carries out his purpose with the help of examples which are replete with charts and diagrams. A list of reference works is included. As is the case with the first paper, this one ends with a discussion by an interested reader.

Use of Statistics to Determine Precision of Test Methods by W. J. Youden and J. M. Cameron, both of the National Bureau of Standards is the last of the papers. This is another

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WE CARRY TUBE TO YOU

WE CARRY TUBE TO YOU

YOU CARRY ON FROM HERE

YOU CARRY ON FROM HERE

One of our prospects (prior to becoming a customer) asked us whether we would sell tubing to him and also accept orders for tubing from *his* customers.

We shouted an emphatic "No!"

That question is often asked by those who select concerns to supply material as components of their finished products or for sale over their counters.

Over many years we have maintained a definite policy of *not* competing with our customers. We try to protect their interests for we sincerely appreciate the relationship we have with them.

As a customer, you can feel free to come to us for any help you need, knowing that your problems can be discussed with us in strict confidence.

If you're our customer, we like that. And we're not your competitor, so you like that.

Let us be of help to you.

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Sales Offices in Principal Cities

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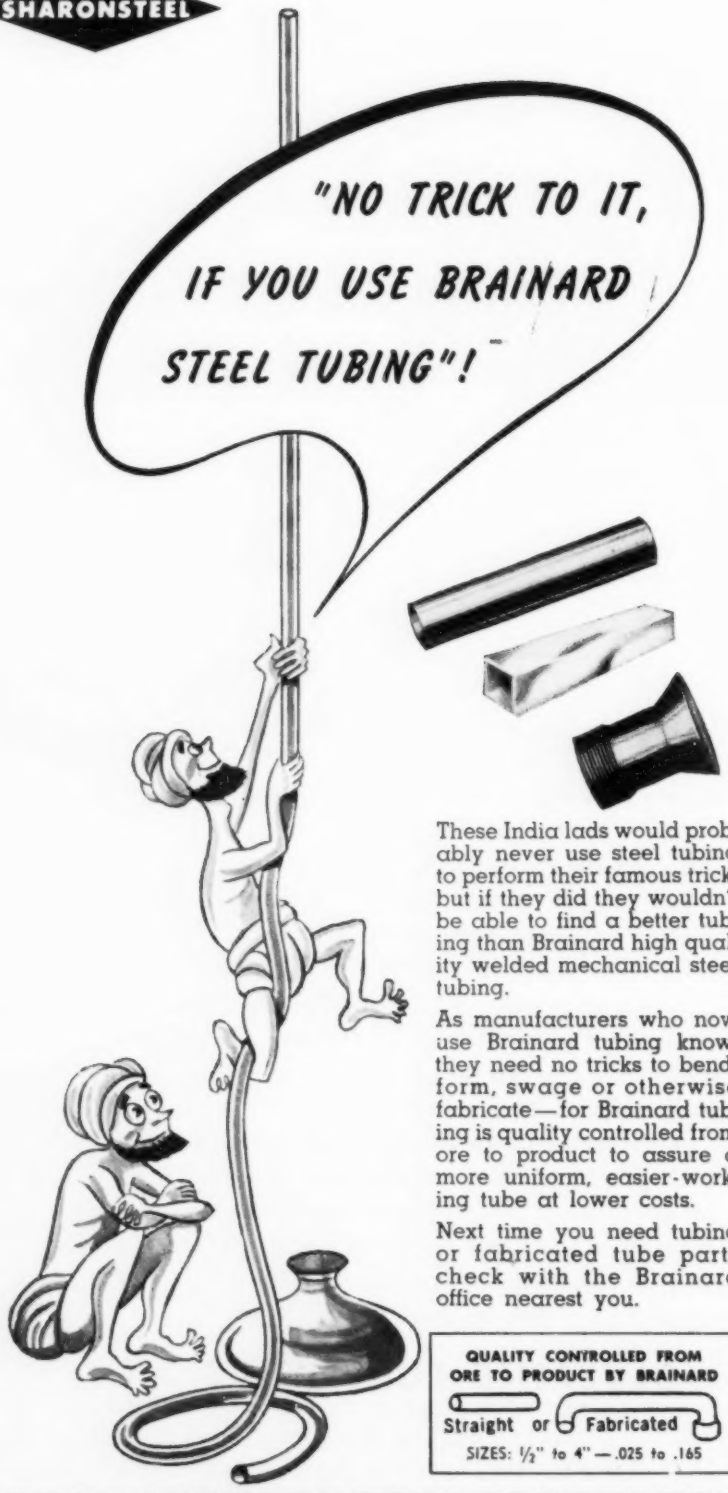

These India lads would probably never use steel tubing to perform their famous trick, but if they did they wouldn't be able to find a better tubing than Brainard high quality welded mechanical steel tubing.

As manufacturers who now use Brainard tubing know, they need no tricks to bend, form, swage or otherwise fabricate—for Brainard tubing is quality controlled from ore to product to assure a more uniform, easier-working tube at lower costs.

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discussion of the use of statistical techniques to check up on the adequacy of test methods by determining, in the case of any one test method, the standard deviation of the test method, what proportion of material which is below specification will get by the test, and how the test method stacks up against some other alternative test method. The authors use as an example A. S. T. M. Method D877-46T, the test for determining the dielectric strength of insulating oils. Tables of the data involved and formulas to make use of these data are part of the presentation.

Illustrating For Tomorrow's Production

J. H. FARMER, A. J. HOLDER *and* F. F. VAVRIN. 203 *pages*, 6 x 9½ *in. Published by Macmillan Company, 60 Fifth Avenue, New York* 11, *N. Y.* $5.

Pictorial illustrating plays a valuable part in American industry as a visual aid in the various steps of production. From the designer's original concepts, perspective illustrations are useful in conveying his ideas and helpful in choosing a particular design. During manufacture, pictorial drawings are valuable by facilitating the assembly of complex machines. Pictorial illustrations are important also in advertising where the selling points must be clearly emphasized.

This book endeavors to explain the significant details of illustration work. It is based on the authors' extensive teaching experience and shows in easy steps how to make perspective drawings. Each step is clearly described by many illustrations. Although the fundamentals of this type of work are given in most drawings texts, many ideas and devices are described which should be of use to the illustrator. This book should make a handy reference.

List of Equivalent Valves

H. GORDON HAWES. 175 *pages*, 8½ x 11 *in. Published by Hooper Publishing Company, 545 Sansome St., San Francisco* 11, *California.* $15.

This listing is intended as a ready reference for engineers, purchasing agents and engineering personnel who develop valve specifications or who purchase valves. It is basically a guide to the differences between the valves offered by 18 leading manufacturers. It shows which valves are equivalent and their variations in design.

The list is broken down by mate-

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Shown here are four basic types of Century Protected Motors which are designed to resist the dangers of hazardous atmospheres. A properly selected Century motor—with the right protection—is the ideal combination for a long life of satisfactory performance.

1 **Open Protected**—Form J, general purpose motor—meets the needs for most installations where operating conditions are relatively clean and dry. The top half of the motor frame is closed to keep out falling solids or dripping liquids.

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3 **Totally Enclosed Fan Cooled Motor** — protects against dusts, mist or fog that might be detrimental to the vital parts of the motor. The inner frame protecting the motor is sealed to keep out harmful matter.

4 **Explosion Proof Motor** — protects against atmospheres charged with explosive dusts or gases. They carry Underwriters' label for specific kinds of hazards.

Century builds a complete line of alternating and direct current motors in a wide range of types and kinds—in sizes from 1/6 to 400 horsepower.

Specify Century motors for all your electric power needs.

Popular types of standard ratings are generally available from factory and branch office stocks.

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Century C MOTORS

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DEPENDABLE
outstanding features assure unexcelled performance from
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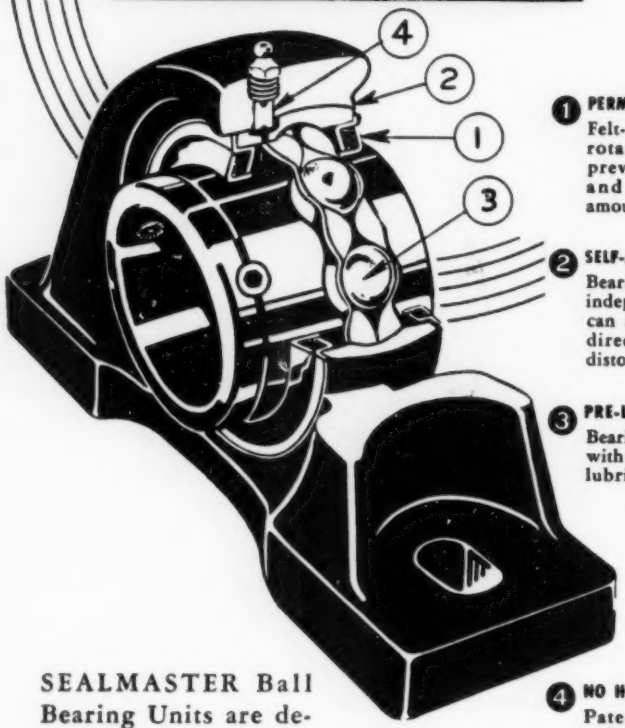
BALL BEARING UNITS



1 PERMANENTLY SEALED! Felt-lined steel flinger rotating in labyrinth prevents entry of dirt and retains proper amount of lubricant.

2 SELF-ALIGNING! Bearing unit, with seals independent of housing, can align itself in any direction without seal distortion.

3 PRE-LUBRICATED! Bearing chamber is filled with proper amount of lubricant before shipment from Seal-Master factory.

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SEALMASTER Ball Bearing Units are designed and constructed to give maximum service at lowest cost. An exclusive combination of design features assure smooth-running, dependable operation. Machine designers specify SEALMASTERS to insure customer satisfaction and product integrity. Write for a copy of Catalog 845 for your files . . . it gives the complete SEALMASTER story.

Request Catalog 845 . . . It gives dimensions and load ratings for pillow blocks, flange units, take-up units, cartridge units and flange-cartridge units.

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rial; by the type of valve; and by the catalog pressure rating. For each section there is an index to enable the user to locate readily the page or pages covering the valve in which he is interested.

Since some manufacturers rate a valve primarily for water service by working steam pressure, while others rate it by water, oil or gas, a table based on general practice is included that enables the user to determine the equivalent rating for either specification when the other is known.

Automatic valves, stop checks, plugs and cocks, pressure sealed and other special types are not listed.

Without having to hunt through 18 different catalogs, an engineer with this list can arrive at a decision as to which two or three valves best suit his application. Then by referring to those two or three catalogs the engineer can appraise the value of any special features and make his selection. The use of this listing should make it unnecessary to search through a number of catalogs and to study the variations in standard types of valve design.

To keep the listing abreast of any changes in the various valves covered, new pages will be compiled at the end of each year. These pages will be available on a subscription basis.

Problem Layouts for Technical Descriptive Geometry

B. LEIGHTON WELLMAN, *Professor of Mechanical Engineering and Head of the Div. of Engineering Drawing, Worcester Polytechnic Institute.* 116 *sheets,* 9¼ x 11 *in. Published by McGraw-Hill Book Co., Inc.,* 330 *W.* 42*nd St., New York* 18, *N. Y.* $2.75.

Contained herein are a group of problem layouts prepared for use with the text, "Technical Descriptive Geometry", by B. Leighton Wellman published by the McGraw-Hill Book Co., Inc. in 1948 and reviewed in PRODUCT ENGINEERING in the October issue of that year.

Each of the sheets, which are perforated for easy removal and punched with 3 holes for filing, has a layout which duplicates the conditions of a problem from Chapter 11 of the author's "Technical Descriptive Geometry." Each sheet is numbered in the lower right hand corner, and this number corresponds with the similarly numbered problem in the text. Sheet 5-2, for example, is the layout for the second problem in Group 5 of Chapter 11. Although some problems can be solved in several different ways,

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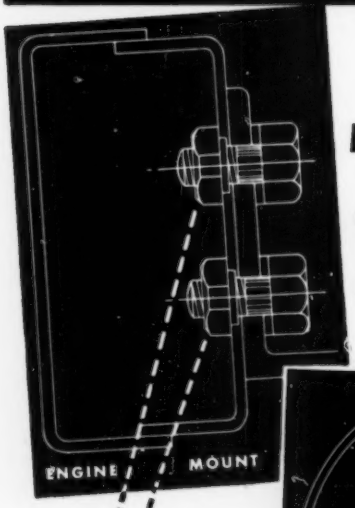

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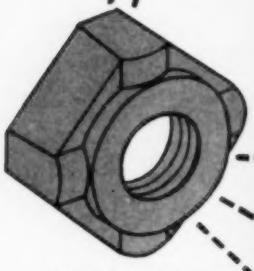

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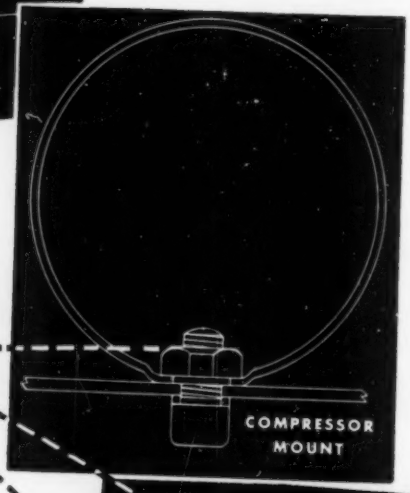

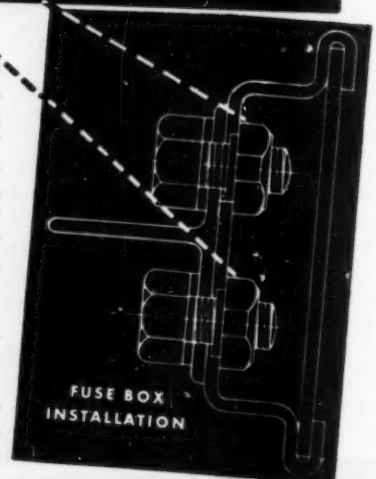

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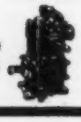

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the position of the given views on the sheet will usually indicate the desired form of solution. The title block contains spaces for the school's name, the draftsman's name, the date and other pertinent data. In one corner of the title block is a grading scale for the instructor's convenience.

Beginning with a group of simple layouts from whose given views other principal views and auxilliary views are to be drawn, the series continues on into the more complicated problems with which descriptive geometry is concerned. Many of the problems are practical ones such as determining the true bend angles of a tube when given two views or finding true guy wire lengths from two given views. At the end are eight blank sheets which have been included for special problems that the instructor may wish to assign.

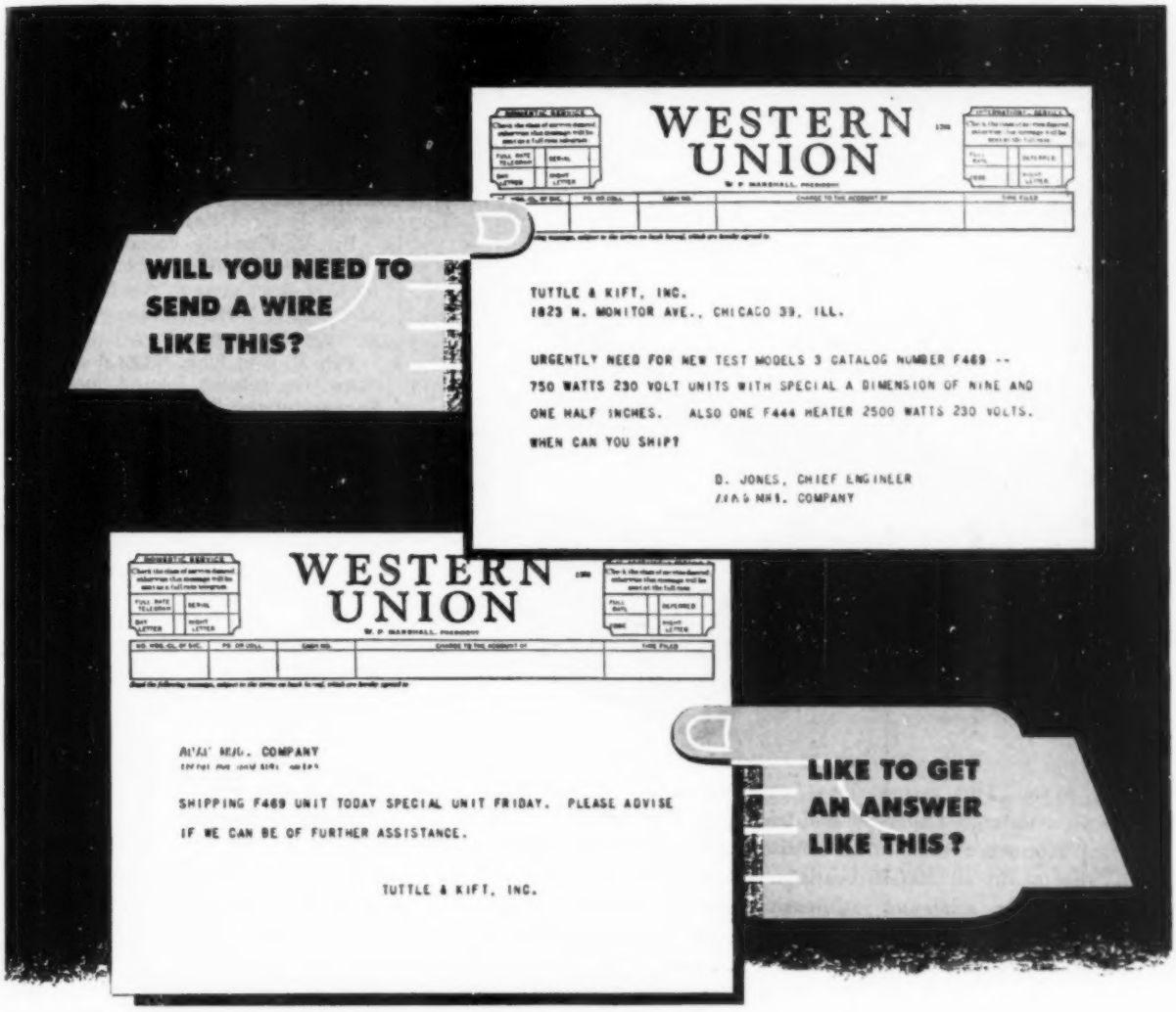
Principles of Engineering Economy

EUGENE L. GRANT, *Professor of Economics of Engineering, Stanford University. Third edition, 623 pages, 6 x 9 in. Published by the Ronald Press, 15E. 26th St., New York 10, N. Y.* $5.00.

There have been many definitions of engineering, most of them sound and many of them amusing. "Boss" Kettering's definition was "Engineering consists of brains and materials—and the more brains, the fewer the materials". The author of this volume has taken his theme from Arthur M. Wallington's classic remark that engineering is the art of doing well for one dollar what any bungler could do for two dollars.

In the preface to the first edition of the volume, Professor Grant pointed out that many engineering graduates feel that the most serious omission in their technical education was the failure to emphasize the economic aspects of engineering. Even in many successful companies, decisions affecting the cost of a product are often made on the basis of "half-facts" and assumptions. Partly, that is the result of the failure of management to provide adequate engineering personnel to investigate various methods of accomplishing the same result not only on an engineering basis but on a cost basis as well. PRODUCT ENGINEERING took cognizance of that fact in 1949 and in 1950, and devoted two entire issues each of those years to designing for lower cost.

Although "Principles of Engineering Economy" is intended primarily as a text for undergraduate courses in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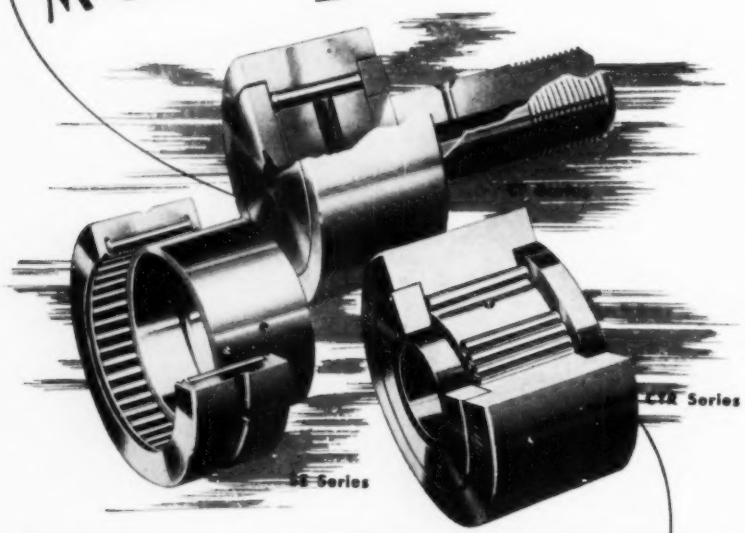

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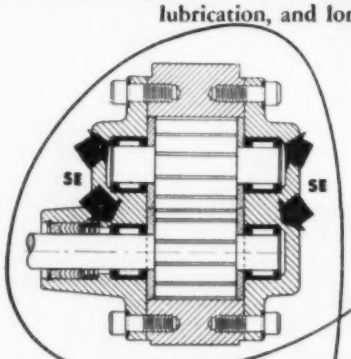

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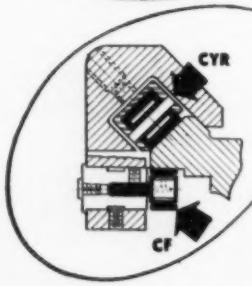

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engineering schools, it is interestingly written and contains a wealth of information that is of value to the engineer. Naturally, the text contains essentially principles and methods of analysis, not specific design data.

The breakdown of the book in section and chapters is as follows:

Part I, Planning Economy Studies to Solve Engineering Problems: Chapter 1, Hunch Decisions Are Dangerous and Chapter 2, Business Decisions Are Between Alternates.

Part II, The Time Element in Economy: Equivalence, Interest Formulas, Solving Interest Problems, Why Interest, Annual Cost, Present Worth and Capitalized Cost, and Calculating a Prospective Rate of Return.

Part III, Technique for Economy Studies, is even more thorough in treatment and Part IV, Getting Results from Economic Studies, reemphasizes the important principles.

More than two-thirds of this book has been rewritten. The general plan of organization of the preceding edition has been retained. Just as in the earlier editions, the fundamental objective has been to explain the technique of answering "Will it pay?" questions in engineering situations.

Procedure Handbook of Arc Welding Design and Practice

Ninth Edition, 1200 *pages,* 6 x 9 *in. Published by the Lincoln Electric Co., Cleveland* 1, *Ohio.* $2.00 *in the U. S.;* $2.50 *elsewhere.*

In a new 9th Edition, the "Procedure Handbook of Arc Welding Design and Practice", published by The Lincoln Electric Company of Cleveland, Ohio, has been completely reorganized and re-edited to bring all information up-to-date and include recent important welding developments. New design data has been included to make the Handbook more helpful to designers of welded machines and structures. Latest procedures are given for welding all metals and alloys commonly welded with manual open arc and hidden arc welding as well as automatic and semi-automatic hidden arc welding.

A completely new chapter on weldability has been written to present a comprehensive survey of this important subject. The latest information gathered from research projects and recent studies gives the facts which have changed welding procedures on many types of metals in the last few years.

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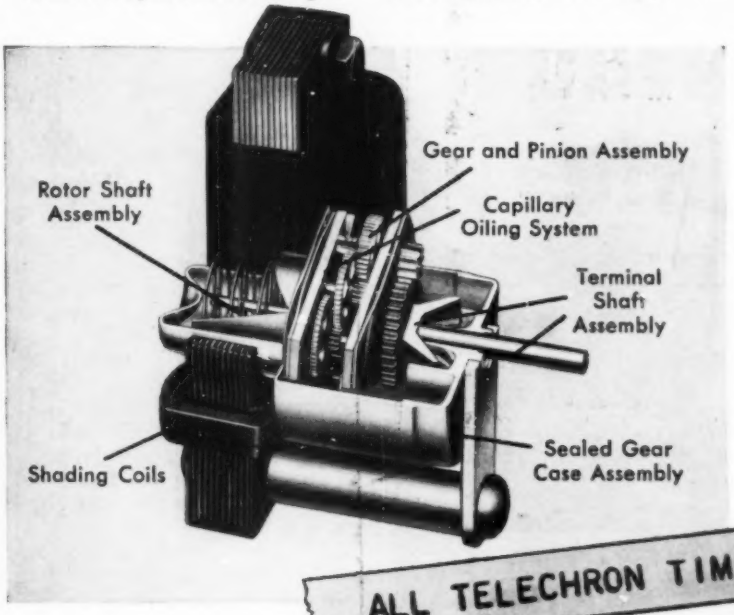

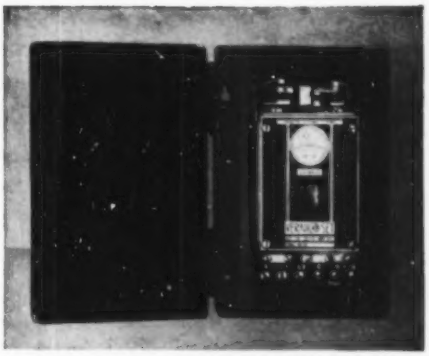

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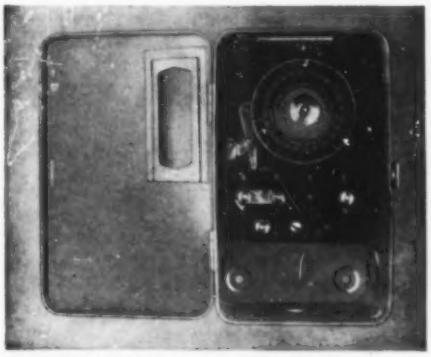

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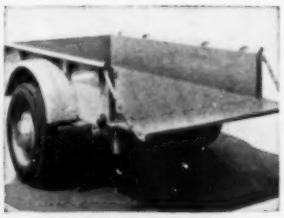

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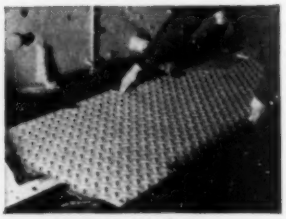

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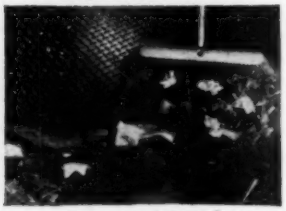

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been enlarged and revised to include more information on welded rigid framing. Design techniques developed by leading consulting engineers for recently erected structures are included.

The machine design information in the Handbook has also been enlarged to include more information on the welded design of machine tools. This is in addition to the design data revised for other machinery of all classifications.

A completely new chapter has been added to the handbook on welded design data. This chapter presents the fundamentals of welded design for both machinery and structures. It gives fundamentals, such as stress allowables, which can be applied to particular design problems. This chapter gives a designer the necessary tools for approaching any problem he may have in designing for welding. The new 9th Edition contains more than 1300 photographs and drawings.

Theory of Flow and Fracture Of Solids—Volume I

A. L. NADAI, *consulting mechanical engineer, Westinghouse Electric Corp. Second Edition. 572 pages, 6 x 9 in. Published by The McGraw-Hill Book Co., 330 W. 42nd St., New York 18, N. Y. $10.*

This is the first book of a two-volume revision of the author's pioneering work, *Plasticity*. The previous edition treated the plastic deformation of solids only. In this edition, the scope is broadened; the general conditions causing fracture of materials are surveyed, and a discussion is included of the details and results of a number of experimental investigations on the yielding and fracture of ductile materials under combined stress.

Mathematical principles and mechanical laws governing flow and fracture are emphasized. The author discusses particularly the yielding of metals under simple stress such as bending and torsion, and analyzes problems associated with the elastic, the very viscous, and the ideally plastic substances.

Included are some of the major results of recent experimental investigations that deal with the mode of yielding steel, formation of strain figures, advancing plastic fronts, fracture surfaces of metals, and other related research findings.

Several new chapters offer an introduction to the theories of simple and composite substances based on elastic and permanent strains, and on the

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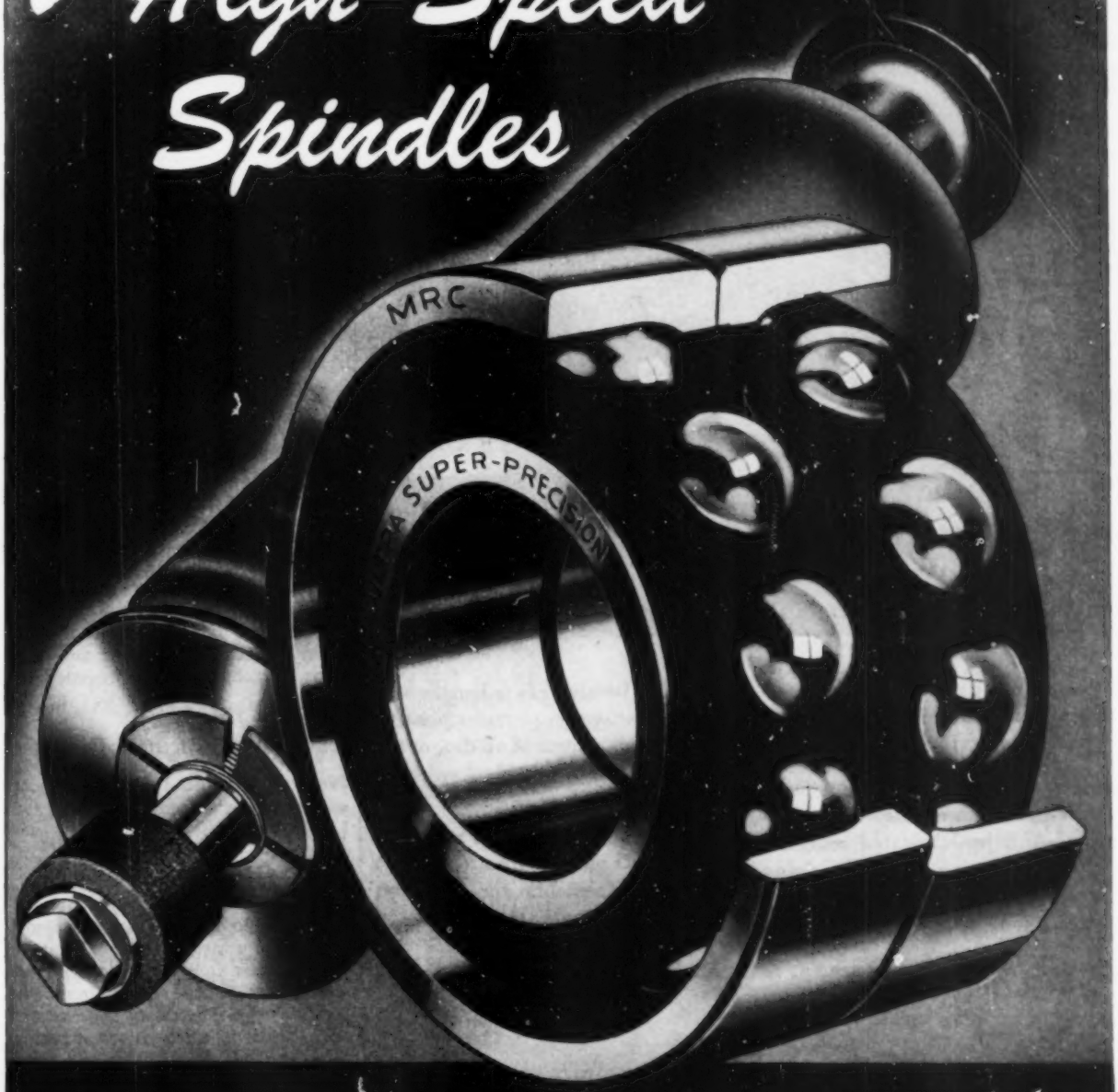

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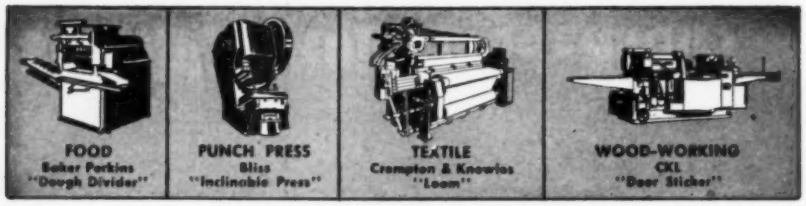
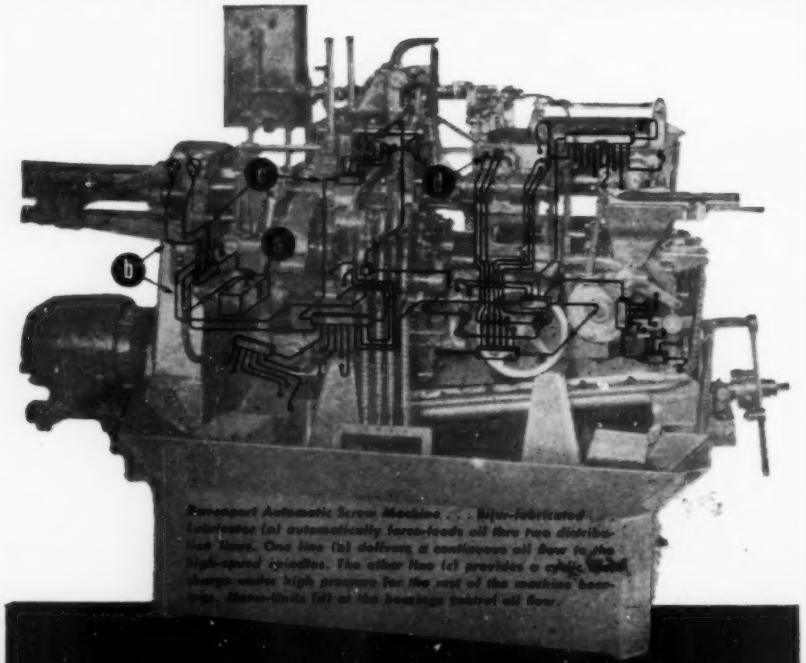


automatic lubrication



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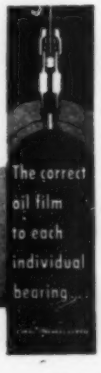
Next, maintenance costs are cut as effective bearing life is lengthened. The Bijur system provides positive Meter-Unit control of oil flow *at the bearings*, considerably reducing bearing wear.

When you design that new machine, call on the Bijur engineer. Meanwhile, for further information write for "The Travels of Modern Lubrication."



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types of laws of deformation postulated. The treatment of the states of stress in permanently strained cylinders and disks, and the mathematical theory of the nonhomogeneous states of plastic strain and of their surfaces of slip, have been revised.

In this volume, the author renews his effort to clarify the Mohr representation of stress and infinitesimal strain in making a broader use of their octahedral components, with the help of which many important facts in the theory of plasticity have found their simplest expression.

Casting and Forming Processes in Manufacturing

JAMES S. CAMPBELL, JR., *assistant professor of mechanical engineering, Rensselaer Polytechnic Institute.* 536 *pages,* 6 x 9 *in. Published by The McGraw-Hill Book Co., Inc.,* 330 *W.* 42*nd St., New York* 18, *N. Y.* $5.

The volume describes all casting processes, plastic molding and forming, powder metallurgy, rolling, forging, sheet metal working and punch press work. The scope of the book does not include machining and welding.

The discussions introduce the student to the mass production point of view, and enumerate the important advantages and disadvantages of each process. Design rules associated with the various procedures are presented. The book is intended for mechanical engineering students to supplement their shop courses in the patternshop, foundry, and machine shop.

Numerous line drawings and halftones are included to clarify and illustrate the subject matter presented.

Aluminum Structural Design

Prepared by PAUL BRANDT, *technical advisor, Reynolds Metal Company.* 130 *pages,* 6 x 9 *in. Published by the Reynolds Metal Co., Louisville* 1, *Kentucky.* No charge.

The revised edition gives basic information on how to design original load-carrying structures of aluminum or to convert an existing design from some other material to aluminum. In addition to the necessary equations to calculate the internal stresses of beams, columns, and plates, there is a short discussion on deflections and vibrations.

This booklet contains a considerable number of tables listing the physical properties of the many aluminum alloys and the characteristics of standard shaped sections.

In this summary of technical developments, space restrictions do not allow giving complete details. Further information relating to any item can be obtained by writing to the Editor of Product Engineering.

Metallic Materials

WEIGHT REDUCTION, the perennial problem of aircraft designers, has led to experimentation with aluminum conductors in the relatively low-voltage electrical systems. Insulated cables and bus bars represent one-third of the system weight in large planes -- the use of aluminum would mean a saving of nearly 100 pounds.

HEAT-RESISTANT ALLOY containing 21.0 chromium and 9.0 nickel is highly ductile, yet creep properties are comparable to those of the popular 26-12 cast grade. Reduced alloy content is significant cost-wise for non-carburizing applications in temperature range from 1,200 to 1,650 Fahrenheit.

SOME OF THE MATERIALS now under test for possible future use in airplanes include magnesium alloys, titanium, metal-face sandwich constructions, rolled tapered sheet, thin integrally-stiffened sheet, tapered extrusions and structural adhesives.

STEEL PLATE heat-treated to minimum yield strength of 100,000 psi is high on the ductility and toughness scales. And it's claimed to be at least two to three times as resistant to atmospheric corrosion as plain carbon steels. Carbon content is 0.18 max so that welding and gas cutting are no problems.

IRON POWDER that physically resembles Swedish sponge iron and has a purity of 99.8 iron is the latest entry on the powder metallurgist's list. Partial shape and structure are such that green strength is high and compacts of low apparent density (down to 1.6) can be made. Sintering temperatures range from 1,300 to 1,500 Fahrenheit.

A MOLYBDENUM COATING on dissimilar metals and alloys may be useful in applications where an object's surface is raised to extremely high temperatures and therefore must resist corrosion. Plating by reduction of molybdenum pentachloride vapor may make this possible.

HIGH-TEMPERATURE ALLOYS containing nickel, aluminum and molybdenum look like good bets as turbine blade materials. Mechanical properties at 1,500 F are reported equal to those of the best cobalt-base casting alloys.

ALUMINUM PAINT is good for temperatures as high as 1,000 F. Films sprayed or brushed on the surfaces of furnaces, ovens and heaters do not blister or flake after long exposure to various types of high-temperature atmospheres.

Nonmetallic Materials

MOLDING AND EXTRUDING are the stock-in-trade of a new silicone rubber that has high strength, excellent electrical properties and is stable between 85 and 550 F. Only a five-minute warm up is necessary in forming such products as diaphragms, boots, sleeves, belting, hose and mountings. Stock can be pigmented in various colors.

A BLUISH-GREEN TINT identifies a new grade of glass that cuts out about one-third of the sun's glare-producing rays and one-half the heat rays. Iron oxides tint the glass which was developed for use in automobile windshields.

SILICONE-BASE ENAMEL boasts the surface hardness and chemical resistance of porcelain, yet is not nearly as brittle as the standard appliance finish. Only apparent shortcoming is that new enamel is not quite as heat resistant.

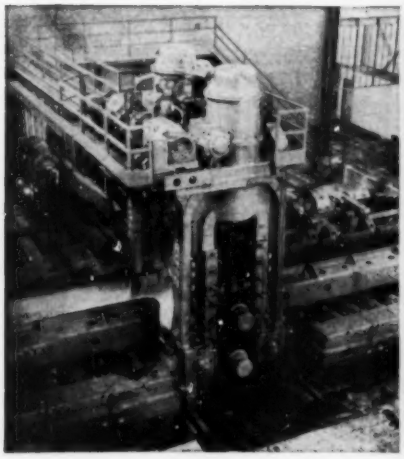
LOW-PRICED REFRACTORY has melting point in excess of 3,300 F, does not crack or chip in a cold-water spray while at 2,550 F temperature. Material is made in form of firebrick, and both grain and ramming mixes.

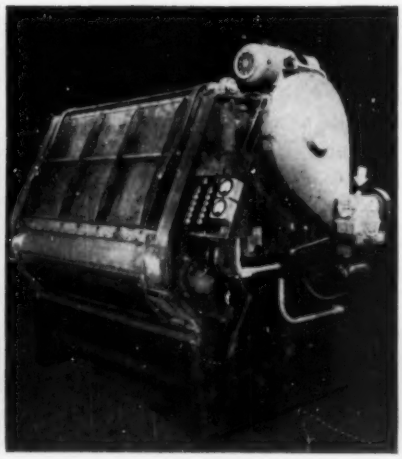
Continued on Page 7

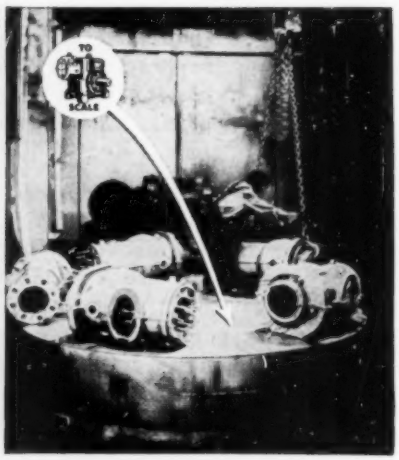
For Iron and Steel, too

CONE-DRIVE GEARS save

Space–Money–Headaches







HANDLE HEAVY DUTY LOADS

For example, this Morgan Engineering Company 40″ blooming mill, like other Morgan equipment (box-chargers, trolleys, etc.) uses Cone-Drive gears to handle the full torque heavy-duty shock loads of the screw-downs. Center distance of the gear sets is only 24 in. to handle 150 hp at 460 rpm using a mill type motor. It would take a much larger non-Cone-Drive gear set to approach the same load capacity, of course.

SAVE MONEY IN CONTINUOUS SERVICE

Wheelabrator Tumblasts know how to "take it"—the loader and mill are operated through standard Cone-Drive reducers. WHY? American Wheelabrator & Equipment Corporation says: "We use Cone-Drives for this application because they conserve space, give us freedom from service trouble and SAVE US MONEY." The unit shown (under construction) has a capacity of 30 cu. ft. of castings. The reducer is a 5″ center distance (4.6 hp at 780 rpm) Cone-Drive.

GIVE RESERVE CAPACITY IN LIMITED SPACE

This Hydro-Blast turn-table turns 25 tons of castings at one time under high pressure streams of sand and water. Operated through a Cone-Drive double-reduction unit (600 to 1) made up of *standard* 2½″ and 5″ reducers. Over-all height is less than 19 in. Nearest other reducer would have been 26″ high. Yet the Cone-Drive reducer (shown to scale) has a torque capacity of 25,000 in.-lbs, some 11,000 in.-lbs in excess of actual requirement.

CONE-DRIVE GEARS

CONE-DRIVE GEARS *Division, Michigan Tool Company*

DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS

7171 E. McNichols Road • Detroit 12, U.S.A

A THREE-WAY IMPROVEMENT is the key to the newly revised SAE crankcase oil classification. Grades 60 and 70 have been dropped because of their limited usage; grade 5W has been added on the basis of its good sub-zero properties; and viscosities have been specified for temperatures at which the oils operate.

LIQUID FLUX dispensed as a spray from a 4-oz squeeze-squirt can speeds up soldering of most any metal assembly. Cleaning and burnishing operations are not necessary.

QUICK-DRYING FINISH for brass, iron, gold, cadmium, chromium and nickel will find a ready market on door knobs, trunk locks, cabinet handles and escutcheon plates.

Processes

WROUGHT OR CAST PARTS made of aluminum and its alloys are being chromium plated to increase wear resistance. A blast of quartz crystals suspended in water removes oxides and roughens surface. Cleaned parts are then plated in an acid bath, resulting in a plate having a Rockwell hardness of C75 to C82.

SURFACE IMPERFECTIONS often found on die cast parts can be minimized by using a shot control to regulate the flow of metal. Reduced initial flow followed by full application of hydraulic pressure permits filling the die without producing swirling and spraying--the causes of flow marks, cold shuts and other surface irregularities.

ULTRASONIC ENERGY is being applied to yet another field -- in a small, low-priced washing machine that shakes the dirt out of clothes. Unit is about 13 in. long, and 6 in. in diameter, weighs only seven pounds and will sell for a fraction of the cost of current models.

BRAZING STEEL for 2,000-F service is no trick if Colmonoy No. 6 nickel-chromium hard facing alloy is used in a hydrogen atmosphere at 2,150 F. Resulting joint is claimed to have physical properties comparable to those of stainless at 1,600 to 1,800 Fahrenheit.

STEEL AND COPPER WIRE pre-coated with electrolytically deposited nickel can be cold-drawn, welded, bent or twisted without danger of loosening the coating. Smooth, corrosion resistant finish on uniformly thick nickel is the result, regardless of the wire's configuration or cross-sectional shape.

WORN SHAFTING is being restored to original dimensions by a simplified procedure. Several thousandths of the metal are taken off the bearing surfaces which are then built up with plated chrome to the exact dimensions desired. Final precision grind is thus eliminated and a smooth surface obtained.

ILLUMINATED GLASS may be on the market in the near future. According to brief reports, glass treated with a luminous agent becomes lighted when energized from ordinary power lines.

RELATIVE MERITS of argon and helium for inert gas arc welding appear to boil down to the following: Helium has hotter, more penetrating arc and is faster; while argon is "smooth", "soft" and slower with less penetration. Mixtures of the two gases permit tailor-making an arc to fit a given welding operation.

Components

SEALED FLEXIBLE COUPLING has crowned-tooth gearing that permits shaft misalignments as great as 7 deg. Applicable to compressors, internal combustion engines and pulverizers, couplings have bores ranging from 1 5/8 to 5 in. and capacities from 12 to 350 horsepower.

LIQUID RHEOSTAT for controlling the speed of wound rotor motors covers full resistance range in only 10 in. of travel. Device is suited for use under variable torque loads such as induced and forced draft fan drives, centrifugal pumps, blower and compressor drives.

COMPACT SOLENOID has stroke of 1 3/8 in. and pull varying from 6 to 16 lb in constant-duty units and 11 to 29 lb in intermittent-duty assemblies. Operable on any a-c voltage and frequency, the solenoids exhibit minimum heating and have double shading coils for reducing hum.

TENSION REGULATOR for heavy cables compensates for temperature changes and slack developed during service. A spring and hydraulic

Continued on Page 9

Another new development using

B. F. Goodrich Chemical Company *raw materials*

B. F. Goodrich Chemical Company does not manufacture this fabric. We supply raw materials for the compound only.

Safety Idea

...CLOTHES THAT FIGHT FIRE!

Versatile Geon opens up another sales field

IT seems there's no end to the sales-building ideas that Geon materials stir up. Take these new flame-resistant clothes, for example. They're made of a fabric that's treated with a Geon latex compound. They help to protect workmen against fire.

Most important, these clothes can't continue to burn once any directly applied flame is removed. Gases formed by the flame-proofing compound completely extinguish any blaze. Dangerous afterglow is eliminated.

That's just the start of the compound's advantages. The fabric *stays* flame-resistant even after repeated launderings in any type soap or detergent wash. It has good "feel", good tensile strength and abrasion resistance. Shrinkage is negligible. It's non-toxic and mildew-proof. It's comfortable to wear—and long-lasting.

This new treated fabric is another in a long line of Geon-helped successes — durable flooring, stain-and-wear-resisting upholstery and wall covering, improved wire and cable insulation are other typical examples.

They may stir up ideas for you. We'll gladly help you with technical advice to start them on their way as sales-makers for you. Geon materials come in many forms—including resin, latex and compounded plastics. We supply them as raw materials only—no finished products. For information, please write Department GO-6, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio. In Canada: Kitchener, Ontario. Cable address: Goodchemco.

GEON RESINS • GOOD-RITE PLASTICIZERS . . . the ideal team to make products easier, better and more saleable.

GEON polyvinyl materials • HYCAR American rubber • GOOD-RITE chemicals and plasticizers

piston-valve mechanism take care of the adjustments as they are needed.

CARTRIDGE-TYPE SWITCH precisely controls electric circuits when actuated by hydraulic pressure. As little as 12 to 18 percent pressure differential is sufficient to cut circuits in or out at ambient temperatures ranging from -65 to + 160 Fahrenheit.

OIL-BATH AIR CLEANER for fractional horsepower engines has a transparent plastic outer case in place of the customary metal housing. As is the case with plastic water holders that fit storage battery cells, the level and condition of the oil can be determined at a glance.

FOUR-SPEED TRANSMISSION based on geometric progression of 1.7:1 has overall ratio of 5:1 and provision for special ratios up to 9:1. Unit is rated 20 hp at 900 rpm input speed.

TORQUE-ARM REDUCER handles output speeds ranging from 115 to 330 rpm. Unit comes in four sizes, with capacities as high as 27 hp. Interchangeable shaft-keyed bushings ease transfer of the reducers from one machine to another.

Testing

ENDURANCE LIMIT of bolts, studs and other threaded fasteners is increased by a new fatigue-resistant thread form designed to minimize notch effect. Height of the thread is materially reduced because the radius at the root is increased to the maximum. Although not destined to be a standard thread form, the new configuration will find its place, mainly in applications where parts are subject to intermittent or cyclic loads.

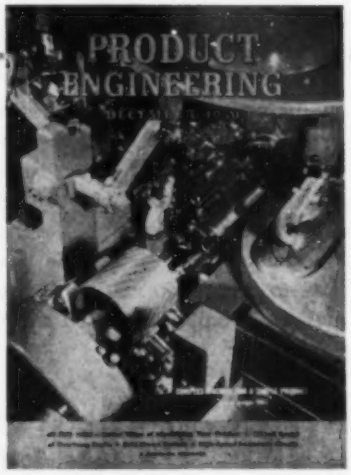
INSTRUMENT PANELS containing large members of round dials are generally difficult to illuminate preparatory to photographing. Reflections from the dial glasses and uneven light distribution are usually the primary problems. But by recessing a bulb in each of the spaces between dials, uniform glareless lighting over the entire panel can be had.

MEASUREMENT of the angles between X-rays and films or surfaces at which the rays are directed is the key to calculating the thickness of paint films. Techniques can also be used to study the oxidation process and identity special alloys.

DIRECT MEASUREMENTS of electrical "grounds" can be made with either of two new instruments--one manual and one automatic. Both will detect insulation resistance on a-c and d-c systems, whether they are energized or not.

"TRANSPARENT METAL", technically silver chloride, may help to unlock the secrets of a metal's behavior. Because its mechanical properties, elastic constants, compressibility, thermal expansion and crystal structure are quite like those of many metals, the clear compound can be used to study the internal behavior of metals.

RADIOACTIVE COPPER can be used as tracers in thin electrodeposits. As the copper disintegrates, a photo-sensitive film will darken in proportion to plating thickness and density.



THIS MONTH'S COVER

The American Machine and Foundry Company makes a specialty of highly complex equipment. An automatic bowling pin setter, now under test, cigarette making machines, and packaging and vending machines are examples. Another is the type 2-66 cigar machine, the wrapping mechanism of which is pictured on the cover. Developed by AMF for its affiliate, International Cigar Machinery Company, this machine can be adapted to manufacture nearly 800 types and sizes of cigars by modification of operating elements. Intermittent motion mechanisms, unitized constructions, and an eddy current clutch are features of the design. See page 94 for details. Kodachrome by Sid Carson, McGraw-Hill Studios.

NISILOY

A POWERFUL, POSITIVE INOCULANT

Cuts Final Cost of Gray Iron Castings

by improving

MACHINABILITY, GRAIN STRUCTURE, UNIFORMITY

BENEFITS TO FOUNDRYMEN

Reduces Rejects – Used for structure control of cast iron, Nisiloy helps your foundry meet daily schedules for uniform lots of machinable gray iron castings.

Promotes Sound Castings – Diffusing rapidly throughout the melt, Nisiloy promotes a dense, close-grained product.

Curbs Breakage – Even where section thickness varies sharply, Nisiloy serves to eliminate chilled edges and surfaces, thus affording a tougher cast iron that resists breakage in shop handling.

No Scrap Problem—Containing only elements that dissolve freely in iron, Nisiloy permits remelting sprues and gates in any successive melt without risk of adding chill-forming elements.

Fewer Base Mixtures—Often a single base mixture may be used in the cupola to which Nisiloy is added in the ladle, with the consequent flexibility of pouring off thin or thick sectioned castings as desired.

Write us for full information about this nickel-silicon alloy, one of the most useful products ever offered for improving machinability and structure of gray iron castings.

BENEFITS TO CASTING USERS

Excellent Machining Qualities—The dense, gray, machinable structure secured with Nisiloy reduces machining time, tool wear, rejects and costs.

Increased Wear-Resistance—The formation and distribution of finely divided random flake graphite accomplished with Nisiloy assures highly improved resistance to wear.

Improved Toughness—Nisiloy acts to eliminate hard, chilled areas . . . thus, the casting is thoroughly machinable in thin and thick sections alike and less sensitive to breakage in machining operations and general service.

Dependable Pressure-Tightness—The sound, homogeneous structure attained by inoculating with Nisiloy results in dense cast iron that provides substantially improved pressure-tightness.

Because of unusually heavy industrial and defense demand, rationing of nickel has been in force since July 1st. However, we believe that dissemination of technical data and service experience can help to promote the intelligent utilization of critical materials, so essential in these times. We shall, therefore, continue to issue information on new developments and user experience with nickel-containing materials.

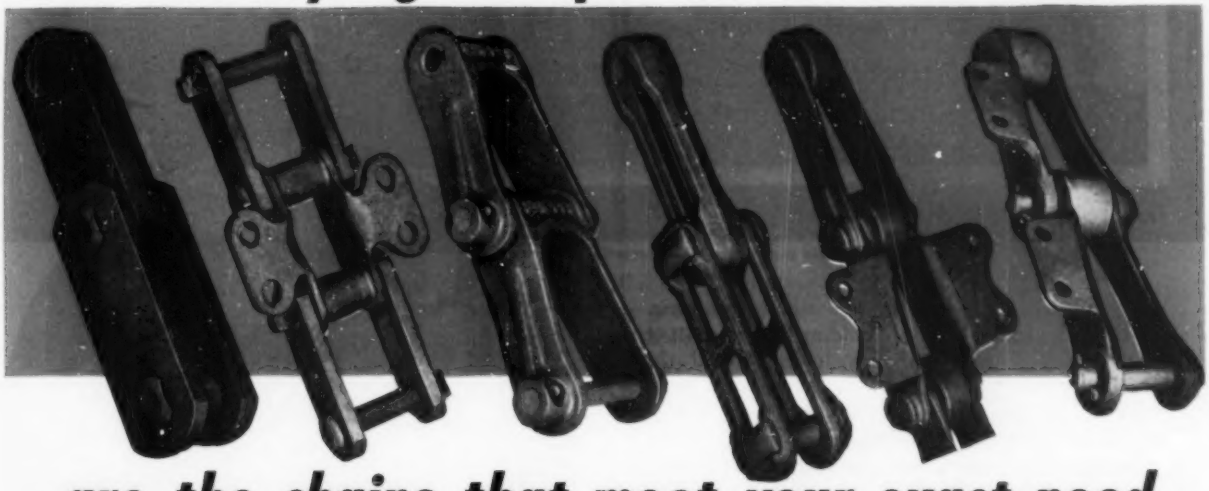
EMBLEM OF INCO SERVICE
TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC.

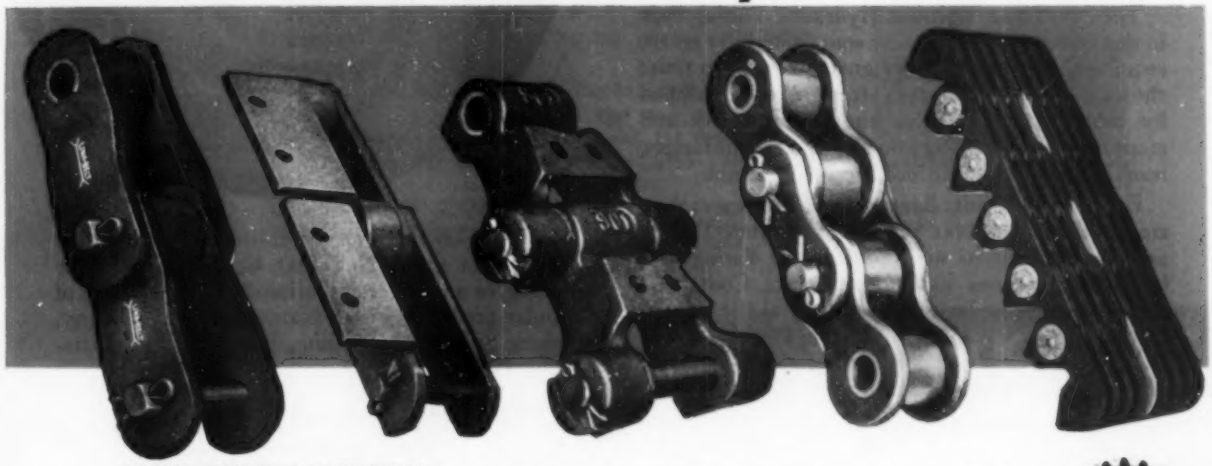
67 WALL STREET
NEW YORK 5, N.Y.

..the chains that serve EVERY industry..

..in conveying and power transmission..



..are the chains that meet your exact need..

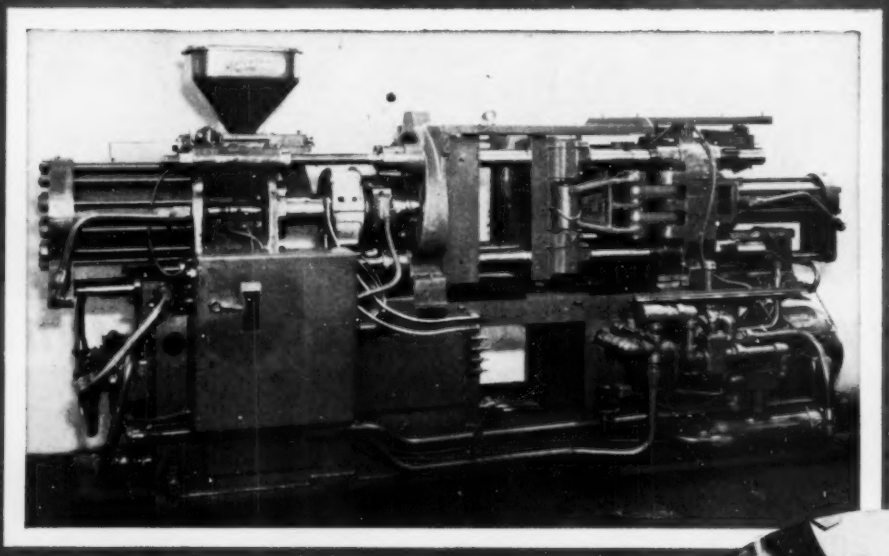


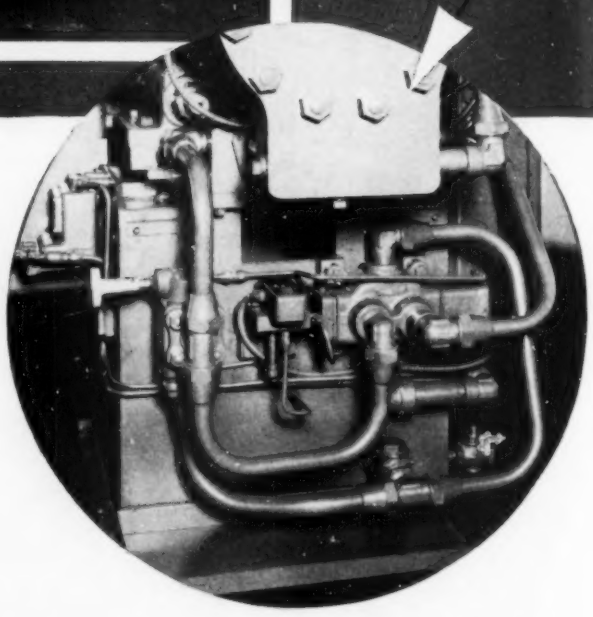
LINK-BELT COMPANY Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Johannesburg. Offices, Factory Branch Stores and Distributors in Principal Cities.

11,254-1

..Chain--by LINK-BELT

To get a dependable 20,000 p.s.i. pressure this manufacturer chose National Seamless Hydraulic Tubing





*Name of manufacturer on request.

Today's plastic injection molding machines have to *produce*—day after day, often 'round the clock. The continuous duty 10D-8 shown here* exerts a 20,000 p.s.i. pressure on each 8-ounce shot of material. And since this machine is hydraulically operated, every part of the hydraulic system must be as near fool-proof as skilled design and materials engineering can make it.

The NATIONAL Seamless Hydraulic Tubing used in this equipment has to meet some unusually severe requirements. It must have great strength to resist the high internal pressures (often greatly multiplied by momentary surges as the piston starts and stops). Also, the tubing must have excellent fatigue resistance to withstand destructive vibration.

Equally important: Specially selected low carbon steel used in NATIONAL Seamless Hydraulic Tubing assures ductility to withstand severe flaring and bending operations *without splitting*. Controlled atmosphere furnaces are used to anneal the tubing, therefore it is exceptionally clean and free from scale. This is vitally important, because it prevents clogged valves due to contaminated hydraulic fluid.

National Tube Company manufactures a complete line of hydraulic tubing, in a wide range of diameters and wall thicknesses. And our engineers will be glad to help you select just the *right* tubing to do *your* job at the *lowest possible cost*. For more information about NATIONAL Seamless Hydraulic Tubing, or any other of National's large selection of tubular products, write: National Tube Company, Tubing Specialties Division, Frick Building, Pittsburgh 19, Pennsylvania.

NATIONAL TUBE COMPANY, PITTSBURGH, PA.

(Tubing Specialties Division)

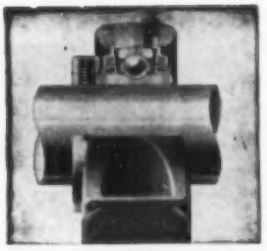
COLUMBIA STEEL COMPANY, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

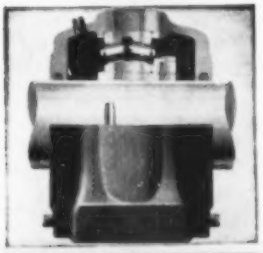
USS

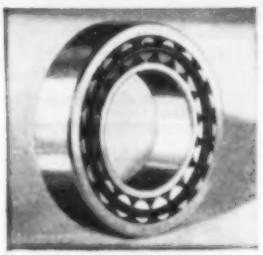
NATIONAL Seamless HYDRAULIC TUBING

UNITED STATES STEEL

Do You have all these . . . in your bearing specifications?







secure locking

Lock a Link-Belt Ball or Roller Bearing to your shaft . . . without distortion • with firm grip • without mislocation • regardless of rotation • with wide distribution of bearing load

housing seals

LINK-BELT Ball and Roller Bearings are "housing sealed" completely . . . to assure free aligning action • to keep out dirt and moisture • to reduce wear under most severe conditions

outstanding manufacture

even by the strict standards of Ball and Roller Bearing manufacture, LINK-BELT is outstanding . . . because of the most modern precision production • because of quality control

serviceability

install LINK-BELT Ball and Roller Bearings and . . . *let 'em roll* . . .
• they are pre-lubricated • they have a large grease reservoir
• they have correct lubrication

product enhancement

gain these advantages from LINK-BELT Bearings in your product:
• dependability • alignability • high capacities
• interchangeability • quality • LINK-BELT service

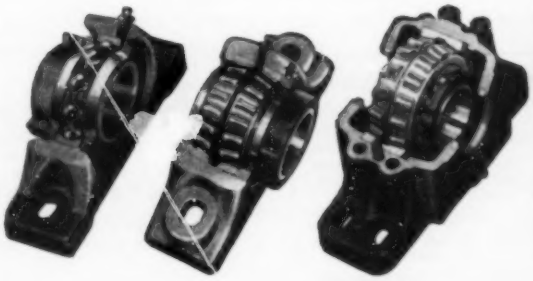
a bearing for every purpose

there is a LINK-BELT Ball or Roller Bearing for . . *every* . . purpose.

An experienced LINK-BELT bearing engineer will go over your bearing requirements with you and make recommendations, without obligation. Send for the complete new LINK-BELT Ball and Roller Bearing Catalog No. 2550.

LINK-BELT COMPANY Indianapolis 6, Chicago 9, Philadelphia 40, Atlanta, Minneapolis 5, Houston 1, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Johannesburg. Offices, Factory Branch Stores and Distributors in Principal Cities. 11,804

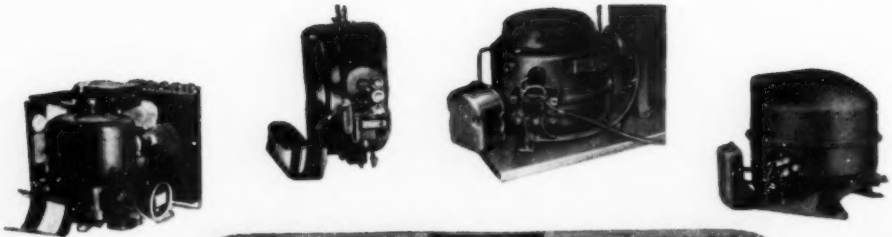
A complete line of bearings is available from stock, throughout the country, in pillow blocks, cartridge, flanged cartridge, flanged, hanger and takeup blocks —also unmounted bearings.

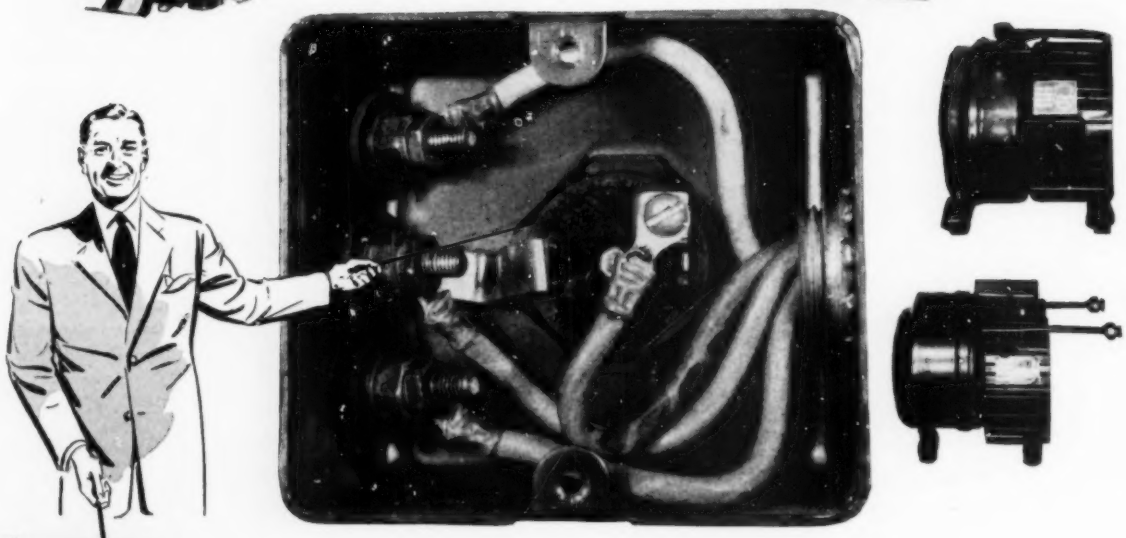


LINK-BELT

BALL & ROLLER

BEARINGS





Another Hermetic Unit Gets

Positive Burnout Protection

WITH

KLIXON *Dome Mounted* PROTECTORS

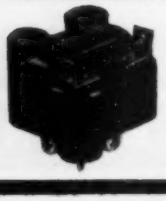
Illustrated, above, is the installation of a Klixon Dome-Mounted Protector in a well-known hermetic unit. Actual operating experience proves that the units protected by Klixon Protectors give years of trouble-free service without burning out.

Here's why — mounted on the dome where they follow every motor temperature change, Klixon Protectors shut the power "off" should the motor become dangerously overheated, regardless of the cause. Then, when the motor cools sufficiently, they snap the power "on" again automatically, enabling the unit to maintain refrigeration.

Because Klixon Protectors provide positive motor burnout protection, they enable the hermetic manufacturer and user to get maximum useable capacity from the motor. This means that smaller HP hermetic units can often be used . . . or the refrigeration capacity of the same unit can be stepped up.

Whether you use hermetic units, oil burners, or other electric motor driven appliances, it will pay you to specify motors with Klixon Protectors. They will reduce your service calls, minimize repairs and replacements . . . help you build and maintain customer goodwill.

KLIXON MOTOR STARTING RELAYS



These dependable relays complete the combination for starting and protecting the motor. Their positive action and long life eliminate starting troubles.

Used and recommended by leading Refrigeration manufacturers.

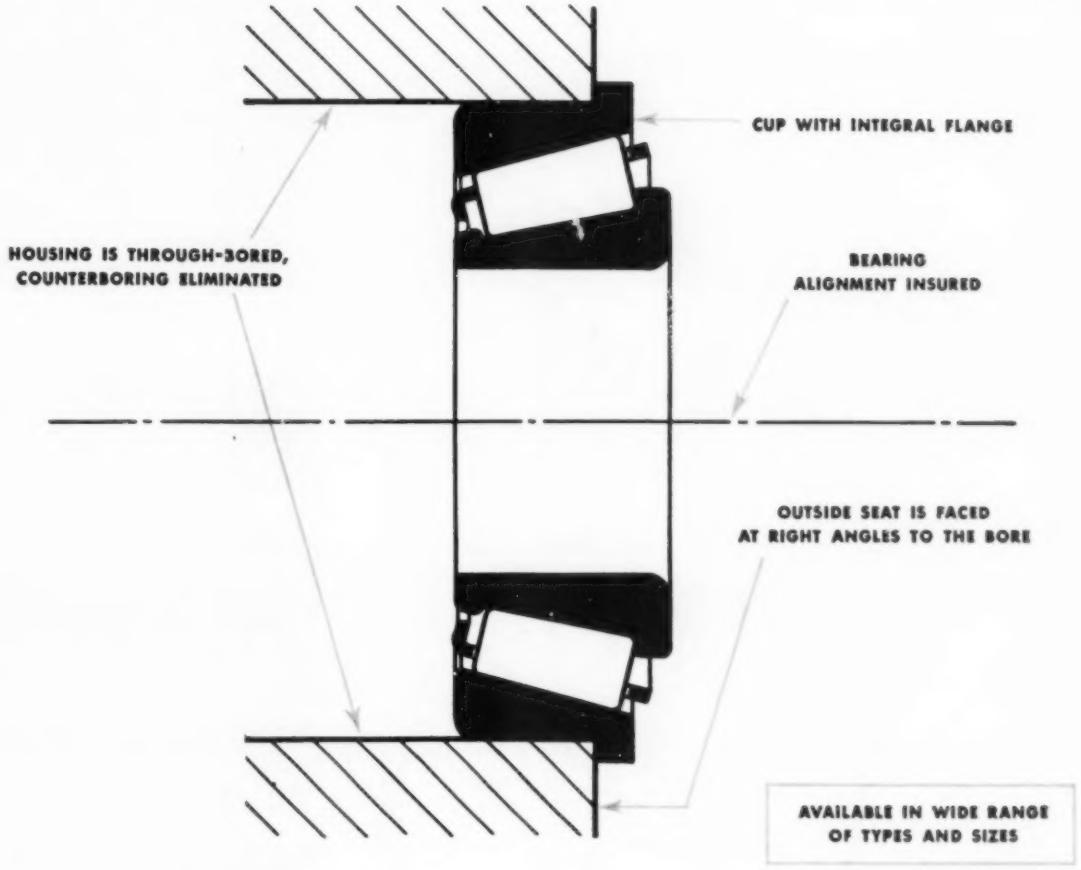
KLIXON

SPENCER THERMOSTAT

Division of Metals & Controls Corp.

912 FOREST STREET, ATTLEBORO, MASS.

Counterboring eliminated, bearing alignment insured, with TIMKEN® flanged cup bearings


CUP WITH INTEGRAL FLANGE
HOUSING IS THROUGH-BORED, COUNTERBORING ELIMINATED
BEARING ALIGNMENT INSURED
OUTSIDE SEAT IS FACED AT RIGHT ANGLES TO THE BORE
AVAILABLE IN WIDE RANGE OF TYPES AND SIZES

TO assure accurate bearing alignment and cut the cost of machining too, the Timken® flanged cup bearing may be your answer.

The Timken flanged cup bearing—one of many types of Timken tapered roller bearings—has a flange integral with the bearing cup. Counterboring of the housing is unnecessary because no internal backing for the cup is required. The housing is bored straight through and the ends are simply faced at right angles to the bore against which the flange is placed.

The Timken flanged bearing is available in sizes ranging from 1.2595" O.D. to 29.000" O.D. For help in selecting the correct bearing for your job, call upon the services of the Timken engineer. Remember, Timken is the acknowledged leader in: 1. advanced design; 2. precision manufacture; 3. rigid quality control; 4. special analysis steels. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

TIMKEN
TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ⊂⊃ THE TIMKEN TAPERED ROLLER ⊂⊃ BEARING TAKES RADIAL ◁▷ AND THRUST —▷◁— LOADS OR ANY COMBINATION

Doehler-Jarvis First ...AS USUAL

One-Piece Die Cast Garnish Mouldings for the 1951 Kaiser

Cast Moulding Gives Best Fit

A notable styling improvement on the 1951 Kaiser is the relative absence of exposed mounting screws on the window garnish moldings.

This is mainly attributable to the fact that the new moldings are manufactured from a one-piece die-cast rather than a stamping.

The greater rigidity of the aluminum die-cast part, supplied to K-F by Doehler-Jarvis, makes fewer mounting screws necessary.

Only two screws—one at each end—are necessary in the long base of the molding, while the stamping required screws along the full perimeter.

Rigidity of the new molding makes it possible to place the top mounting screws through the unexposed upper edge of the door. The front garnish molding is mounted with four screws, the rear with five.

Other advantages of the die-cast are these:

1—The one-piece part provides a better fit. There no fitting problems resulting from variances in welds or metal finishing as encountered in the welded stamping.

2—As compared with stamping, die-casting of the new molding, due to its design, results in a slightly lower per part cost.

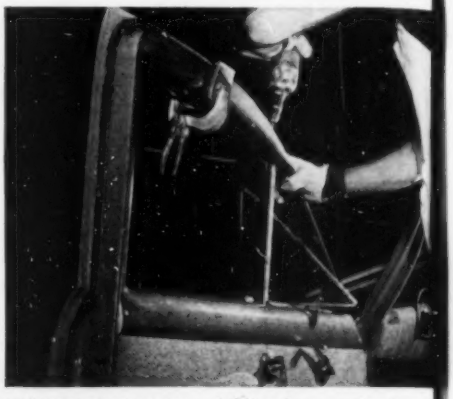
3—The better fit of the die-cast part and the reduction in the number of mounting screws has reduced installation time; with a resultant saving in assembly cost.

4—The better fit and the fact that there are fewer screws to be mounted reduces the possibility of damage to the molding during installation.

Reprinted from Kaiser-Frazer News

Die casting may be the answer to your problem, just as it was for the Kaiser-Frazer Corporation in the production of garnish window mouldings for the 1951 Kaiser. The same Doehler-Jarvis research, engineering, and mass-production facilities which made this development possible are available to you.

DIE CASTING IS SO RIGID that only two screws are needed on the long base.



STYLING IMPROVEMENT—rigfdity also permits placement of top screws through unexposed edge.

ONE-PIECE DIE CASTING gives better fit—reduces assembly time.

DOEHLER-JARVIS CORPORATION

The World's Largest Producer and Finisher of Die Castings

PLANTS AT: TOLEDO, OHIO · POTTSTOWN, PA. · BATAVIA, N. Y. · GRAND RAPIDS, MICH. · CHICAGO, ILL.

EXECUTIVE OFFICES: 386 FOURTH AVENUE, NEW YORK 16, N. Y.

Try Your Luck In Untried Pools!

. . . You may Land a Big One that you never counted on

You may get a strike that will amaze you . . . and your customers, too. You may net a whopper that will weigh up to be *the biggest sales advantage your product ever had* . . . the hidden ability to count to your customers' advantage. Like the milling machine builder who found he could build-in a Veeder-Root Counter to pre-set and control depth of cut.

And on such fishing expeditions, V-R engineers are expert (and remarkably successful) guides. When do you want to try *your* luck? Just write.

Series 1200 Magnetic Counters (for AC & DC), widely used with photo-electric relays or electric-eye equipment. These and scores of other electrical and mechanical counters are shown in FREE 8-page "COUNT BOOK" below. Send for your copy, *today*.

Veeder-Root COUNTERS

"Count Everything on Earth"

VEEDER-ROOT INC., HARTFORD 2, CONN.

Veeder-Root Inc., Hartford 2, Conn., (NEW Telephone Number: HArtford 7-7201)

In Canada: Veeder-Root of Canada, Ltd., 955 St. James Street, Montreal 3
In Great Britain: Veeder-Root Ltd., Kilspindie Rd., Dundee, Scotland

Folding chair improved, assembly simplified by die castings of Dow

MAGNESIUM

the world's lightest structural metal!

A manufacturer of high quality wooden folding chairs decided to build a metal chair incorporating similar design features. To secure the best combination of light weight, fabrication economy and good surface finish, he selected magnesium die castings.

Three magnesium die castings weighing 5⅓ lb. replace 14 wood parts weighing 10 lb. Fabrication is simplified and the chair is lighter. The chair is sturdier, too. It can't warp, splinter or squeak and there are no glued joints to come apart. The baked enamel is cheap to apply, and results in a finish that is attractive, tough and long lasting.

Magnesium die castings have made many products better—more useful, easier to sell. Investigate them for your product. For more information call your nearest Dow sales office or write Dept. MG-56 in Midland.

MAGNESIUM DIVISION

THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN

New York • Boston • Philadelphia • Washington • Atlanta • Cleveland • Detroit
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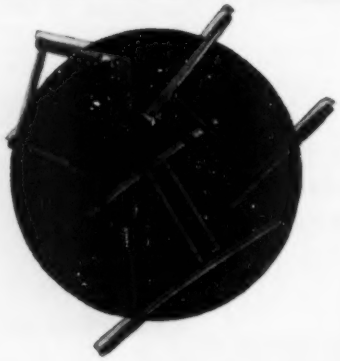
Dow Chemical of Canada, Limited, Toronto, Canada



Magnesium die castings—light, strong, economical

The exceptionally long cores, and large over-all size and area of these difficult die castings demonstrate the excellent castability of magnesium. Its high strength-weight ratio means minimum casting weight. It's also the easiest die casting material to machine. It will pay you to investigate Dow magnesium die castings for your product.

Lighter Products Sell—make your product Magnesium Light

Here's what Safety-Circle means to your customers

✓ All-Around Protection
✓ Low Maintenance
✓ Dependable Performance
The SAFETY-CIRCLE
The Allis-Chalmers Safety-Circle is the frame and ends of heavy cast iron that completely surround and protect the working parts of the Safety-Circle motor.

SAFETY-CIRCLE MOTORS are protected all around against those great motor killers—corrosion . . . distortion and friction.

Frames are of cast iron, which *inherently* resists corrosion. The natural strength of cast iron is supplemented by heavy ribbing and bracing . . . has high safety factor to maintain alignment and prevent distortion. Pre-lubricated bearings are packed and sealed at the factory . . . require no attention for years. And, end brackets are drip-proof at no extra cost.

Safety-Circle Motors are fully protected inside, too. Multiple dipped and multiple baked stator windings plus inter-phase insulation provide extra protection against electrical breakdowns.

CERTIFIED SERVICE

Another reason for supplying *Safety-Circle* motors on your equipment. There are 86 service shops to give your customers quick, factory approved parts and service in every major industrial area. Check coupon at right for details. And, when you do specify *Safety-Circle* motors, be sure to order matching Allis-Chalmers controls.

ALLIS-CHALMERS "Safety-Circle" DESIGNERS' MOTORS

Safety-Circle is an Allis-Chalmers trademark.

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ALLIS-CHALMERS, 1002A SO. 70 ST. MILWAUKEE, WIS.

Please send me:
- Handy Guide for Electric Motors Bulletin 51B6052
- Flange Motor Specifications Sheet 51S7234
- Safety-Circle Motors Bulletin 51B62108

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Company _____

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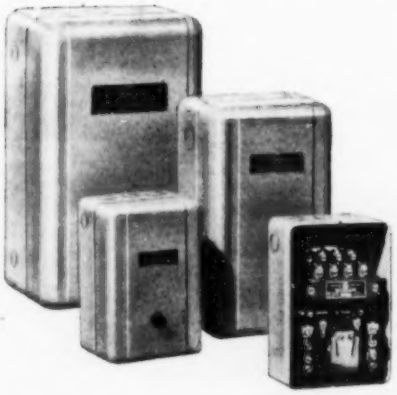
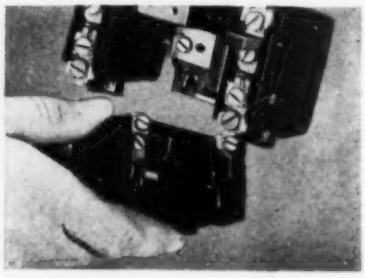
A-3166

Designer's

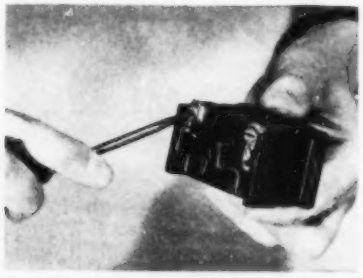
IN DEMAND—because they last longer!



One thing your machinery customers want in a starter is long life—and without expensive maintenance, too. That's why they prefer General Electric a-c magnetic starters, built to last longer than any other you can buy! Get the full story in Bulletin GEA-5153.



1 **Note the coil!** It's the G-E "strongbox" magnet coil, two to five times longer-lasting than conventional coils. Windings can't be damaged by a slipping screwdriver because they're locked in a molded plastic block.



2 **Note the terminals!** Permanently anchored in the coil enclosure, they can't work loose, even after years of operation. And note, too, that they're located on the front of the coil. Makes servicing easier, faster.

Motor Starters

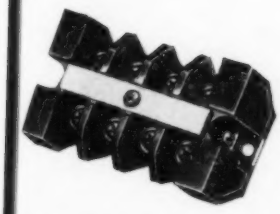
3 **Note the magnet!** Even after it's been in service for years, it moves smoothly back and forth, thanks to the permanent "molded-in" lubricant in the plastic coil block. There's no metal-to-metal friction, no bearings to wear.

4 **Note the contacts!** Made of fine silver, they'll stand up even in toughest "start-stop" service. High initial tip pressure leaves little chance of their welding together. And arc hoods keep each tip protected.

GENERAL ELECTRIC

Digest

PRODUCT HIGHLIGHTS



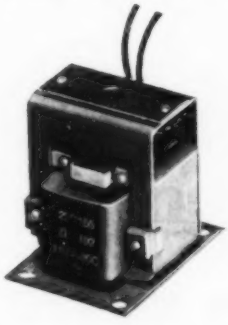
NEW TERMINAL BOARD

—to simplify control wiring

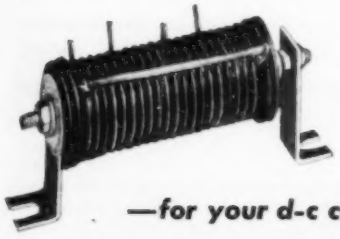
This new General Electric EB-5 fabricated terminal board has washer-head connection screws to speed the job of wiring, testing and checking your circuits. Rated 600 volts, 30 amperes, it's made in 4-, 6-, 8-, and 12-terminal units, to accommodate wire sizes AWG 18 to 10. Reversible, black-and-white plastic marking strips facilitate wire identification. See Bulletin GEA-1497.

SHORT-STROKE SOLENOIDS

—with long-life features



Here's a new General Electric push-type solenoid—for strokes up to $\frac{5}{16}$ inch—built for long life under heavy pounding and rapid duty-cycle operation. One reason for its durability is the rock-hard plastic block encasing the coil and protecting it against moisture, oil, shock and vibration. Others include new riveted magnet structure, stainless steel backstop, and heavy, brazed-on baseplate. See Bulletin GEC-692.



METALLIC RECTIFIERS

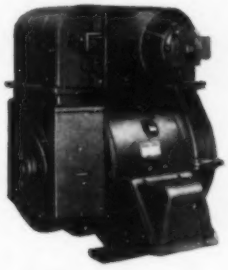
—for your d-c control needs

Convenient conversion of control power from a-c to d-c calls for a General Electric metallic rectifier. Whatever your particular need, meet it with a high-voltage selenium, low-voltage selenium, or copper-oxide type from the complete G-E line. Where high efficiency, uniformity and space economy are all-important, use the new high-voltage selenium rectifier cell shown. See Bulletin GEA-5280.

Dust and dirt can't stop them!

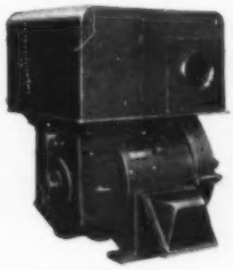
UNIT-COOLED D-C MOTORS

On large machine tools in dusty, dirty or oil-laden atmospheres—that's the place for General Electric totally enclosed, unit-cooled d-c motors. Completely factory-assembled, they save installation time and extra equipment cost. No need for specially built motor room, piping, ductwork, coolant, external filters, or pressurized air supply. Ratings from 15 to 200 hp. See Bulletin GEA-4469.



Single-blower type

For constant-speed or normal adjustable-speed operation—has shaft-driven fan to circulate internal air, and separate motor-driven blower for external air.



Double-blower type

For continuous operation at speeds below normal—uses one auxiliary motor to drive blowers for both internal motor air and external cooling air.

General Electric Company, Section C662-86
Apparatus Department, Schenectady 5, N. Y.

Please send me the following bulletins:

- ☑ for reference purposes
- ☒ in connection with immediate projects
  - ☐ GEA-1497 Terminal boards
  - ☐ GEA-4469 Unit-cooled d-c motors
  - ☐ GEA-5153 A-c motor starters
  - ☐ GEA-5280 High-voltage selenium rectifiers
  - ☐ GEC-692 Short-stroke solenoids

CONSULT YOUR McGRAW-HILL ELECTRICAL CATALOG FOR PRODUCT ENGINEERS!
You'll find "everything electric" for machinery manufacturers in the General Electric section.

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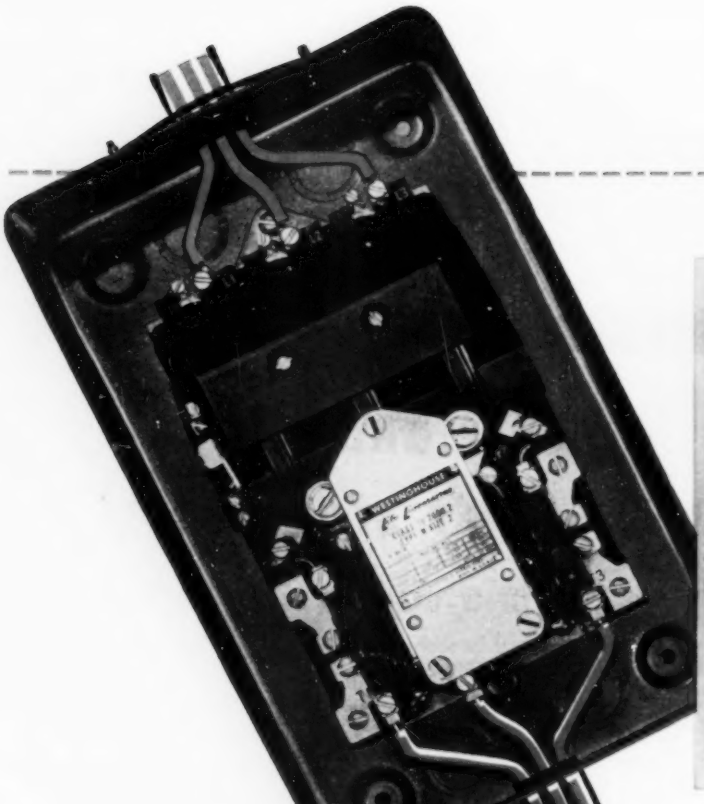
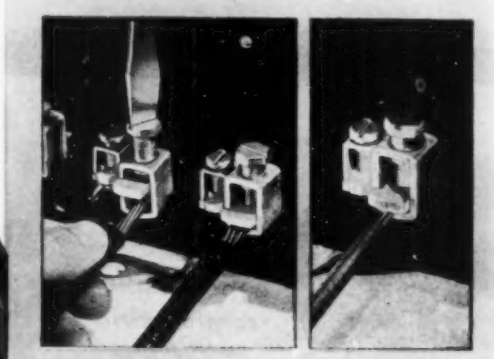
YOU CAN BE **SURE**.. IF IT'S

Westinghouse





PRESSURE-TYPE CONNECTORS

STRAIGHT-THROUGH WIRING

NEW Life-Linestarter*

cuts installation costs 4 ways!

Savings start before they are put in operation . . . with the new Westinghouse Life-Linestarter. New design features permit faster, easier installation—

1. **Straight-through Wiring**—Plainly marked line terminals are *all* at top—load terminals *all* at bottom, permitting simple, straight-through wiring with uniform lead lengths. All terminals are easily reached from the front.
2. **Pressure-type Connectors** speed the job and provide a positive low-resistance connection for either solid or stranded conductor, in a range of sizes to cover all ratings.
3. **NEMA Standard Mounting**—Open starter units conform to the new NEMA mounting dimensions, also to the NEMA sequence of wiring, permitting interchangeability.
4. **Deep-drawn Lift-off Cover**—Exposes unit for easy access. Fastens securely. May be padlocked. No hinge trouble.

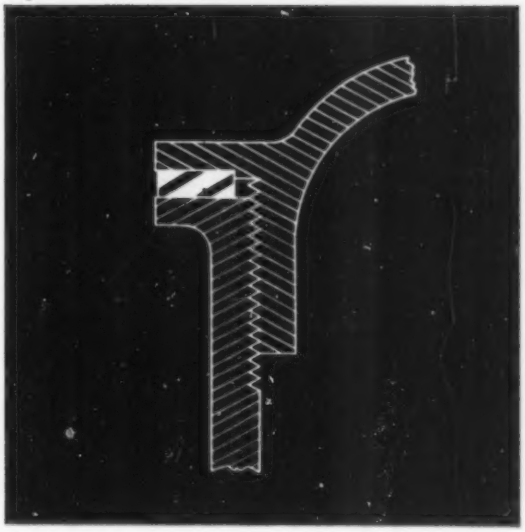
The Life-Linestarter cuts costs in other ways, too—uniformity and completeness of line (NEMA sizes 0 through 4, to 100 hp, 600 volts) . . . superior performance . . . positive protection. Ask your Westinghouse representative to show you "the inside story"—a Trans-Vision presentation. Or write for booklet B-4677. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Penna. J-30025

*Trade Mark

Westinghouse

Life-Linestarter

TOMORROW'S STARTER—TODAY!



How to design joints for efficient sealing

Wherever you find chronic gasket failure or the forced use of high-cost gaskets, you often find a joint design that makes unreasonable demands on the gasket material.

There are occasions, of course, where inherent factors allow little leeway in joint design. In many cases, however, gasket abuse is caused by joints designed without taking into account the characteristics of the gasket material to be used. Under such circumstances there is always the risk that either sealing economy, sealing efficiency, or both may be sacrificed.

A typical example of this hazard is found in the joint illustrated above. As designed, this joint calls for a gasket that is both soft and hard. It has to be soft to conform to the irregular die-cast flanges; it has to be hard to resist torsion during assembly.

A solution was found by coating an Armstrong's Cork-and-Rubber Composition with a lubricant. It is probable, however, that this seal has a lower margin of safety than is desirable. A better solution would have been to catch this problem when the unit was on the drawing board. Then a joint that put the gasket under direct compression could have been provided, eliminating the need for gaskets with two opposed qualities.

There are a number of things that can be done in the design stage to insure better sealing results. When you know the nature of the solvent or other medium to be sealed, the probable internal pressure, and the approximate bolting pressure involved, you can make a tentative choice of a suitable gasket material. Here your Armstrong representative will be glad to offer suggestions based on his experience with many different sealing problems.

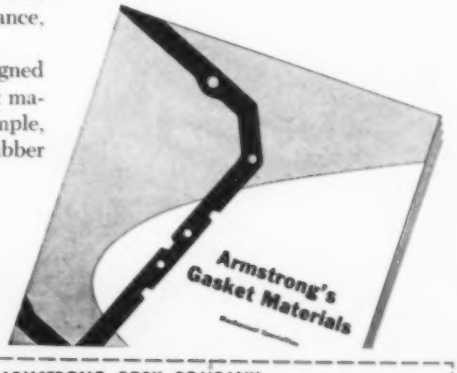
Next, the joint itself should be considered with respect to the needs of the unit of which it is a part. For example, precise alignment of internal parts may dictate a close-tolerance, metal-to-metal flange.

This joint then should be designed on the basis of the type of gasket material initially chosen. If, for example, one of Armstrong's Cork-and-Rubber Compositions has been chosen, the design can be very simple, a channel of the depth and width required by the pressures involved and the hardness or softness of the chosen material. On the other hand, if straight rubber is your choice, either a precision-molded gasket or a relief for side flow may be required, both adding to costs.

All the factors involved in joint and gasket design obviously cannot be covered here. For a more complete discussion of the relation of gasket width to load, the effect of surface condition and of oil on gaskets, practical gasket tolerances, etc., refer to Armstrong's Gasket Materials Manual in Sweet's file for product designers. If you would like a personal copy of the manual, fill in and mail the coupon below.

New Gasket Handbook Now Available

You'll find useful application and specification data in "Armstrong's Gasket Materials." This booklet contains up-to-date information on the various Armstrong's Sealing Materials, plus technical discussions covering many important factors that influence modern joint and gasket design. See Sweet's file for product designers or send coupon for your personal copy.



ARMSTRONG'S
GASKETS • PACKINGS • SEALS

ARMSTRONG CORK COMPANY
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Please send me at once a free copy of the new 20-page booklet, "Armstrong's Gasket Materials."

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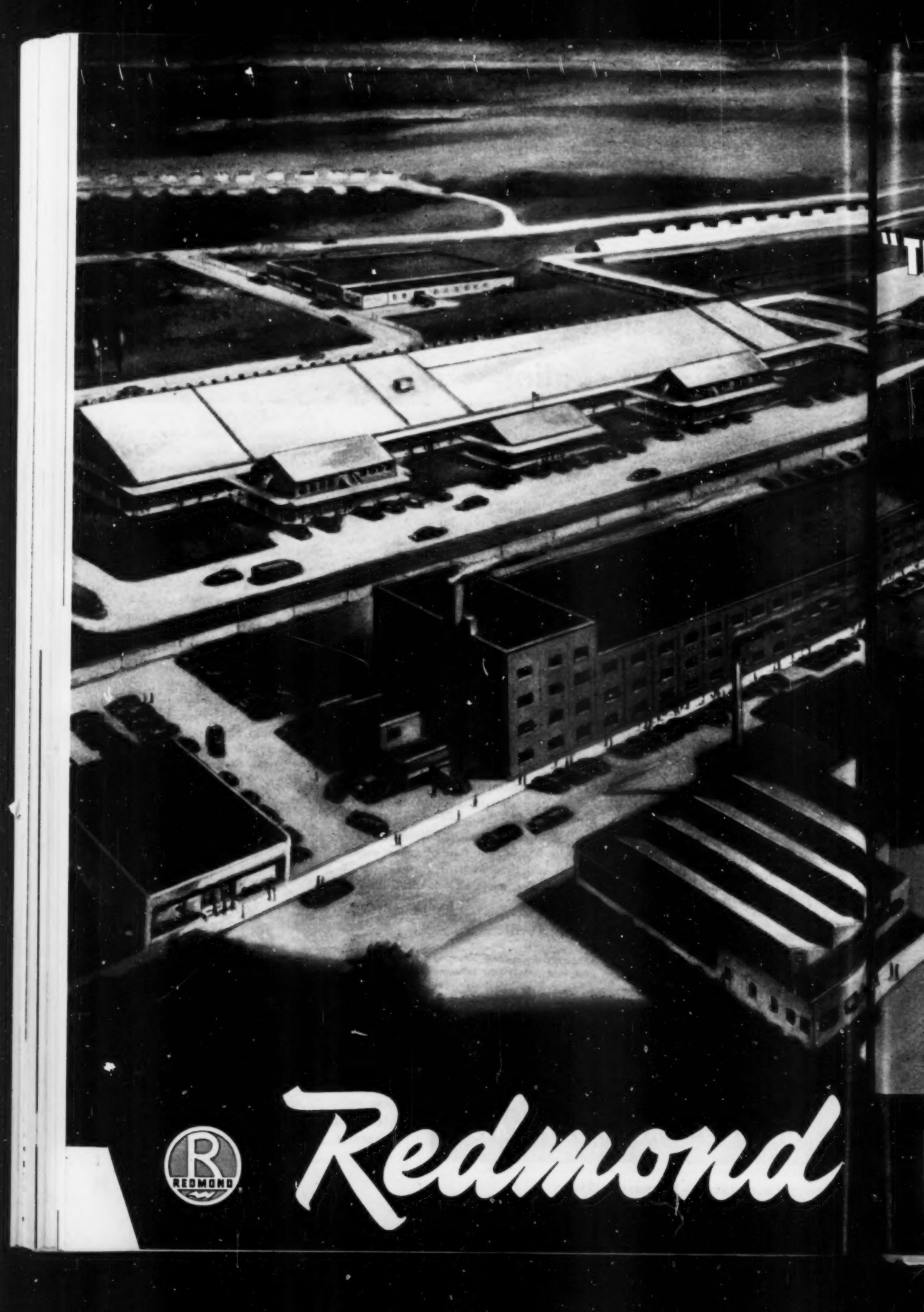
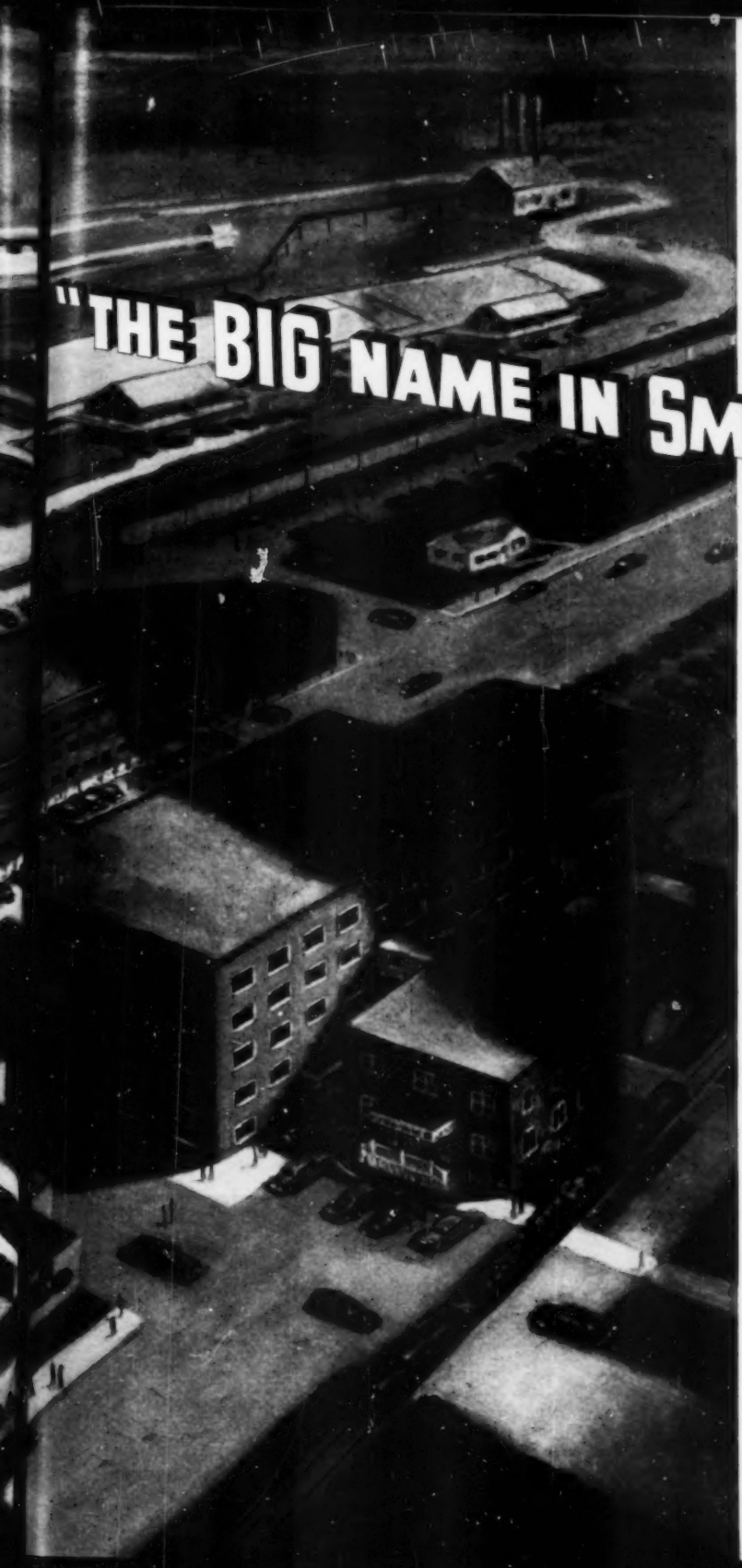
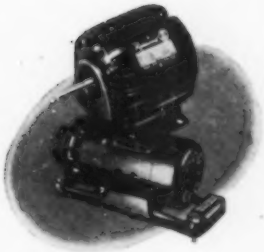

Redmond



"THE BIG NAME IN SMALL MOTORS"



and Manufacturers of Special Equipment for Defense Requirements

The multi-plant operations of the dynamic Redmond organization — in Michigan, Arkansas and Canada—serve you just as though they were the electric motor division of your own organization.

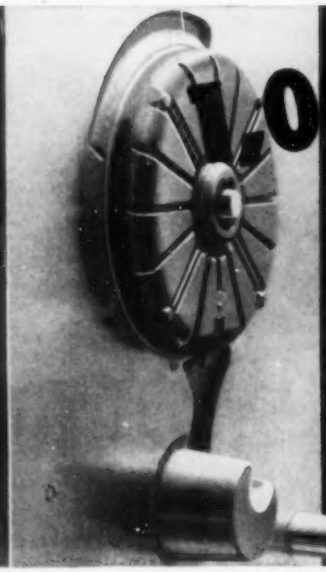
Every year these efficient plants turn out millions of low-range fractional horsepower Redmond Micromotors, in sizes up to 1/10th horsepower, and blowers up to 220 cubic feet per minute output.

For defense requirements, too, Redmond is again ready with the experience to engineer and mass produce precision dynamotors and a variety of other equipment.

When you need quality in quantity, call first on Redmond, the BIG name in Small Motors.

REDMOND COMPANY, INC., Owosso, Mich., U.S.A.
INDUCTION MOTOR SALES OFFICES: *Eastern Area: 430 Lexington Ave. New York 17, N.Y.; Central Area: Owosso, Michigan; Midwest Area: 332 S. Michigan, Chicago 4, Ill.; Southwest Area: 1330 N. Industrial Blvd., Dallas, Texas; Western Area: (Redmond Company of Calif., Inc.) 1248 S. Boyle Ave., Los Angeles 23, Calif.* **SERIES MOTOR SALES OFFICES:** *Owosso, Mich.* **OVERSEAS SALES OFFICES:** *430 Lexington Ave., New York 17, N.Y., cable address, REDISINC-NEW YORK.*

MICROMOTORS



1,000,000 ALUMINUM 4[illegible]0,000 CASTINGS FROM THIS DIE-

and not a mark on its face

CASE HISTORIES FROM MT. VERNON FILES

Here at Mount Vernon, we are proud of our long-lived dies that "stand the gaff", exceed normal life expectancy despite the severe punishment of continuous operation. The one pictured has duplicated the casting shown more than 1,000,000 times — and it is still in use, showing no check marks.

Die casting affords two outstanding production economies: (1) rapid production; (2) reduced machining and finishing.

Both advantages are fundamental factors in establishing lower unit costs. But the degree to which savings may be realized depends upon the quality of the workmanship in making the dies and the care with which they are used. Dies that retain their accuracy for longer periods—yield clean, flawless castings day in and day out—quickly write off initial costs, and reduce ultimate costs appreciably.

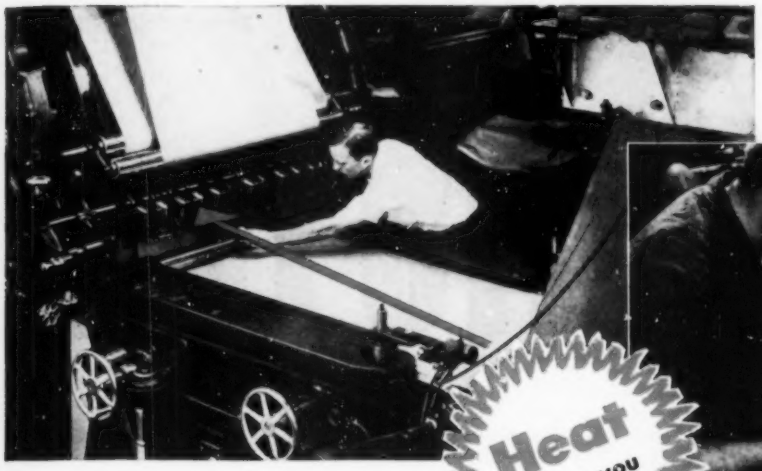
If you have not already profited by the economies to be gained from die casting, consult with us. We are confident that, with our comprehensive experience, skills and modern facilities, we can show you the way to increased output at lower cost.

MT. VERNON
DIE CASTING CORP.
MT VERNON, NEW YORK

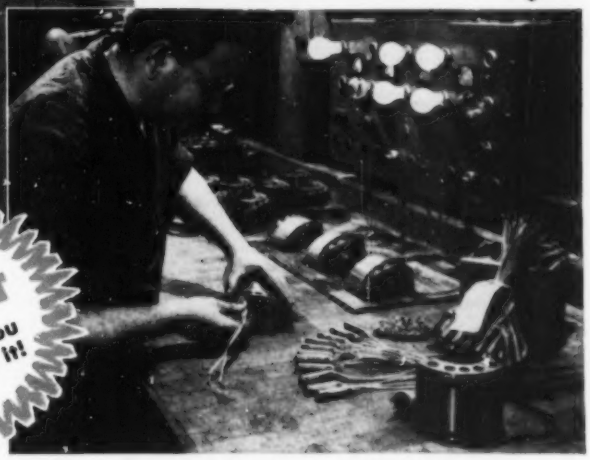
Produced for The Apex Electrical Mfg. Co.
Cleveland, Ohio

CALROD* HEATERS

"Simplest, easiest, and most reliable way to build heat into your product," says Morrison Machine Co.



This Morrison machine, built with G-E Calrod cartridge heaters, accurately shrinks the fabric in warp and weft. Temperatures, controlled by thermostats, are varied according to the fabric being shrunk.



Only a few minutes are required to insert the cartridge heaters into the heating shoes, connect the leads, and fit the shoes over the blanketed cylinders of the shrinking machine.

Heat where you want it!

LIKE THE MORRISON MACHINE CO., designers and builders of textile machinery, you may find that the simplest, easiest, and most reliable way to build heat into your product is with G-E Calrod heaters—tubular, cartridge, strip or fin.

The Morrison Co., faced with the problem of building intense, controllable heat into machines for shrinking textiles as they roll at high speed off the looms, picked G-E Calrod heaters. Here's why—

1. Use of G-E Calrod heaters cut machine manufacturing costs—workmen need only insert the heaters in the heating shoes and connect the leads.

2. Use of G-E Calrod heaters increases customer acceptance and satisfaction because the heaters are reliable and easy to operate.

The trademark, "Calrod," famous for 24 years, is a guarantee to customers that these heaters are designed to stand up under 'round-the-clock schedules. Customers can get maximum use of machinery and maximum output.

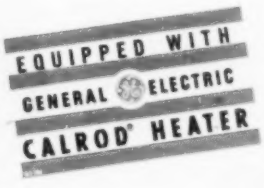
The heaters are easily controlled by thermostats, which can be set for the desired temperature up to 750 F.

** Registered Trademark of General Electric Co.*

Before You Design your equipment for repetitive manufacture, get together with the G-E heating specialist in your nearest G-E office. He'll be glad to help solve your heating problems by selecting from our stock of heaters available in a wide range of standard sizes, ratings, and sheath materials.

NEW, FREE CATALOG

Write us on your letterhead for Bulletin GEC-1005A. And, if you'll also tell us about your heating problems, we'll send you application bulletins to help you select and correctly apply the right heaters to give you heat *where* you want it . . . *when* you want it . . . and in the *amount* you want it. Section 720-29, Apparatus Dept., General Electric Co., Schenectady 5, N. Y.



NEW SELLING AID

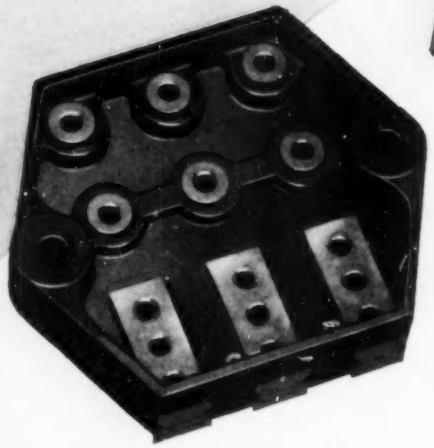
These labels, with a gummed back to enable you to place them on your machinery, are now available.

GENERAL ELECTRIC

720-29

PLASTICS

You're always right with AUTO-LITE



FUNCTIONAL PLASTICS

Plug-in terminal with intricate metal inserts.

. . .

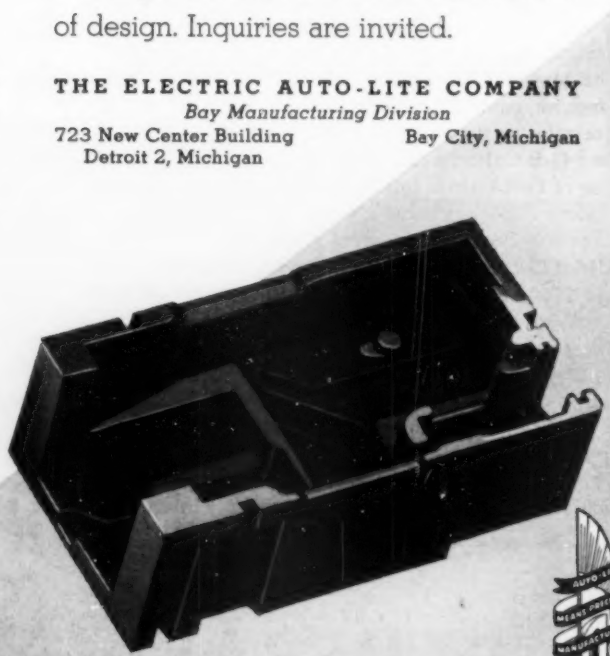
Circuit breaker switch box. All plastic.

. . .

Elastomeric nipples, resistant to breakage, dust, dirt and oil.

New beauty and economy have been made possible through the use of plastics and metal and plastic combinations as produced by Auto-Lite. The artistic skill and forward thinking of Auto-Lite's Art and Style Division is available on matters of design. Inquiries are invited.

THE ELECTRIC AUTO-LITE COMPANY
Bay Manufacturing Division
723 New Center Building, Detroit 2, Michigan — Bay City, Michigan



Tune in "Suspense!". . . CBS Radio Thursdays . . . CBS Television Tuesdays

COPPER ALLOY BULLETIN

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared Each Month by BRIDGEPORT BRASS COMPANY "Bridgeport" Headquarters for BRASS, BRONZE and COPPER

Various types of bolts with rolled threads using silicon bronzes. Courtesy—Russell, Burdsall & Ward Bolt and Nut Company, Portchester, N. Y.

Silicon Bronzes, Correct Tooling Insure Long Life for Bolts, Nuts

The desire of manufacturers to produce bolts and nuts capable of withstanding corrosion and its gradual weakening of parts has led to a widespread use of the silicon bronzes.

The ability of these bronzes to withstand season cracking and other forms of corrosion and their high tensile strengths make them excellent for all types of nuts and bolts, wire and cable connectors, pole line and marine hardware, water meter bolts and valve parts.

Tensile strengths up to 90,000 psi can be obtained in cold formed bolts with silicon bronze No. 609 (approx. 98% copper and 2% silicon).

Silicon Bronze Very Malleable

This bronze is very malleable even in a hard drawn condition, permitting good flow of metal in difficult cold forming applications.

Materials, machines and tools are important factors in cold heading. The choice of the header, in regard to size and number of strokes, depends on the amount or length of material needed to form the upset; the length of the shank under the head, the location of the upset portions on the product and the shape.

Temper Important

Care must be taken in selecting the temper for each cold forming job. If the head is large and thin, softer temper with its increased malleability is advised to prevent heavy tool wear. If the upset is not too severe, then harder temper can be used.

Since cold forming and rolled threading increases the hardness of silicon bronze, the amount of cold work for each job should also be analyzed and temper selected to give the desired tensile strength in the finished piece.

Choice of Header

An approximate formula for the selection of the proper type of header utilizing standard heading practices follows:

1-stroke ..... L=2D
2-stroke ..... L=4D
3-stroke ..... L=6D

D = wire diameter
S = length of wire for shank
L = length of wire for head

Silicon bronzes can be upset to 20 diameters compared to the finished shank diameter by extruding and upsetting in each stage in multiple-station header.

Work in excess of 15 diameters in length of shank should be fabricated in an open die header which is built to open the dies to relieve the pressure on the knockout pins.

These pins are normally made from high carbon steel drill rod.

Steel Inserts Used

High chrome, high carbon steel inserts have been used successfully in round dies. These inserts are turned, hardened in a neutral atmosphere which will prevent decarburization or carburization, then pressed into soft steel holders. The press fits are sufficiently great to cause closing down of the insert inside diameter. The die is then lapped to size. The face of the bushing is held to exactly the same diameter as the head of the bolt. If a larger diameter is used, cracking and chipping of the hardened bushing is possible.

Flow of metal is dependent on the design of die and punch as well as the ductility of the alloy. Working backward from the finished part, definite flow characteristics of the metal can be studied and the coning punches designed to control the flow toward the finished item in two or three-stroke headers.

Laboratory Help Available

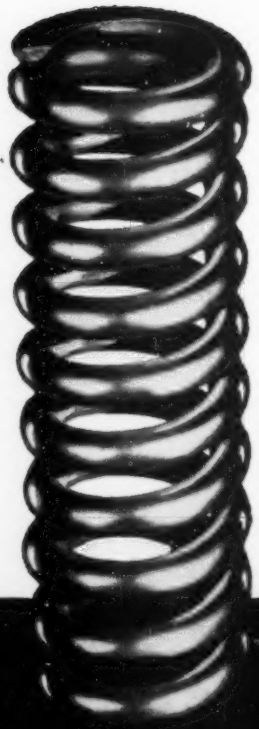
For information of the silicon bronzes and other cold heading alloys, Bridgeport's Laboratory is prepared to cooperate with fabricators of coldheaded parts. Write for Duronze manual.

Stages in production of silicon bronze nut in nut machine—four blows and pierce. Slug is at end. Courtesy—Russell, Burdsall & Ward Bolt and Nut Company, Portchester, N. Y.

BRASS · BRONZE · COPPER · DURONZE — STRIP · ROD · WIRE · TUBING

MILLS IN
BRIDGEPORT, CONNECTICUT
INDIANAPOLIS, INDIANA
In Canada:
Noranda Copper and Brass Limited, Montreal

BRIDGEPORT BRASS COMPANY
BRIDGEPORT 2, CONNECTICUT
Established 1865
"Bridgeport" *District Offices and Warehouses in Principal Cities*



How much should a spring cost?

● It all depends on the job it has to do. Because *overdesign* is just as bad as *underdesign*. You lose both ways—the end product either performs poorly, or it costs too much.

When costs are important, and they usually are, we don't believe in designing springs with unnecessary, elaborate and costly performance characteristics. We don't recommend stainless or high alloy steels if carbon steel will do the job. And we're quick to suggest ways to simplify springs—and cut their cost. You can be sure that, whenever it's possible, our designs will utilize the lowest cost material and fabrication methods that will do a good job for you.

Let our engineering staff—our comprehensive production and testing facilities go to work for you. You'll get a better spring—at a price—that will fit your needs *exactly*.

AMERICAN STEEL & WIRE COMPANY, GENERAL OFFICES: CLEVELAND, OHIO
COLUMBIA STEEL COMPANY, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
TENNESSEE COAL, IRON & RAILROAD COMPANY, BIRMINGHAM, SOUTHERN DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

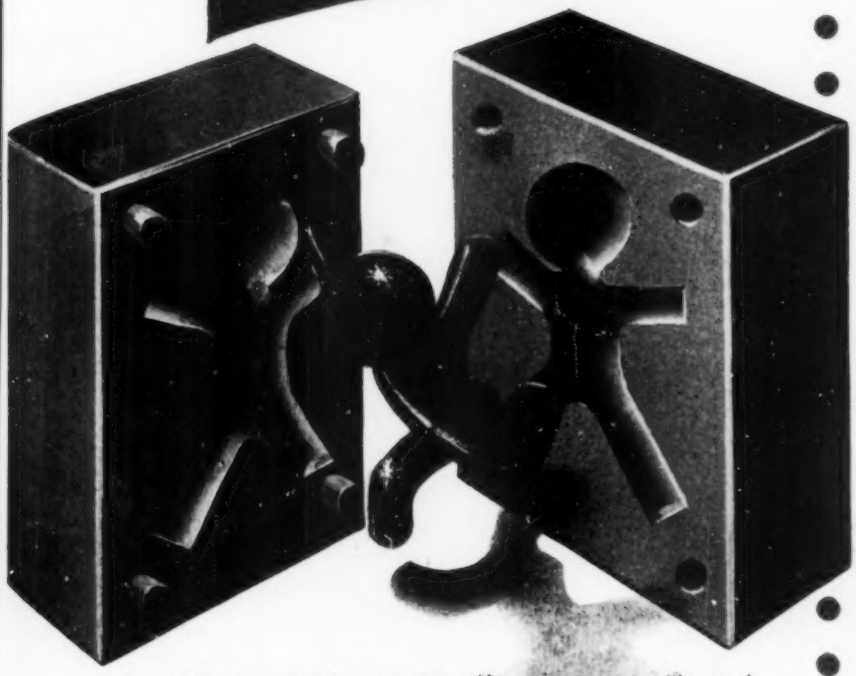
AMERICAN QUALITY SPRINGS

UNITED STATES STEEL

The second in a new series of advertisements designed to tell the G-E Silicone Story to industry.

HOW YOU PROFIT FROM G-E SILICONES'

Better Release from Sticking



One of the remarkable properties of General Electric silicones is *release*—an amazing ability to keep things from sticking. This characteristic makes G-E silicone emulsions, greases, oils, and resins important to industry as release agents of many sorts.

For example, gaskets on railroad car couplings are kept from sticking when coated with a thin film of silicone oil. Food products won't stick to belts or pans treated with silicone resins. Flatirons won't stick to starched fabrics, after being rubbed lightly over a silicone-impregnated pad.

Where is *sticking* a problem in *your* business?

HOW CAN YOU PROFIT FROM G-E SILICONES?

If you can improve your product or manufacturing process by a unique and highly-efficient release agent, investigate G-E silicones! Remember too, that G-E silicones resist heat and cold to a remarkable degree; they are chemically inert; they provide many useful surface characteristics. For more information, write to Section F3, Chemical Department, General Electric Company, Pittsfield, Mass. (In Canada: Canadian General Electric Co., Ltd., Toronto.)

SPEED PRODUCTION OF RUBBER PRODUCTS

General Electric silicone emulsions speed production, cut rejects, and reduce operating expenses when used as mold release agents in the rubber industry. G-E silicone mold release compounds are also useful in die-casting applications.

HELP BAKE BETTER BREAD

By treating baking pans with General Electric's new silicone coating—Dri-Bake*—bakers can increase production schedules. Easy release for as many as two hundred bakes (without re-treating) is possible with this clean, greaseless, non-smoking release agent.

*Reg. U. S. Pat. Off.

GENERAL ELECTRIC

No gas or liquid leaks with this shaft seal!

IF you need to seal a rotating shaft against leakage of gas or liquid, you can count on a *Sylphon Seal* to do the job.

Sylphon Seals withstand pressures up to hundreds of pounds. They're easily mounted and hold firmly. Sealing surfaces are finished flat and smooth to assure completely reliable performance. Friction is reduced, power is saved. Shaft wear is minimized. Rotating shafts are made leak-proof.

Sylphon Seals work so well because they're engineered *on order,* designed for specific applications. *Your* requirements are met exactly.

Size range is wide . . . from tiny instruments up to large marine and industrial installations. Uses are equally broad. Compressors, speed reducers, fluid transmissions and pumps are just a few typical applications.

Send for complete information. Ask for Catalog XP-825. Or, write for helpful engineering service on your problems or specifications.

TEMPERATURE CONTROLS

FULTON SYLPHON DIVISION
Knoxville 4, Tenn.

Robertshaw-Fulton CONTROLS COMPANY

BRIDGEPORT THERMOSTAT DIVISION
Bridgeport 1, Conn.

BELLOWS ASSEMBLIES • BELLOWS DEVICES

TRI CLAD MOTORS

REG. U.S. PAT. OFF.

will run safely without relubrication for as long as any general-purpose motor you can buy—

and if the application makes relubrication a *must*, you can grease a **TRI CLAD** *without* halting production

GENERAL ELECTRIC

HERE
WH1

TRI CLAD MOTORS will ru safely without relubrication fo as long as any general-purpos motor you can buy—

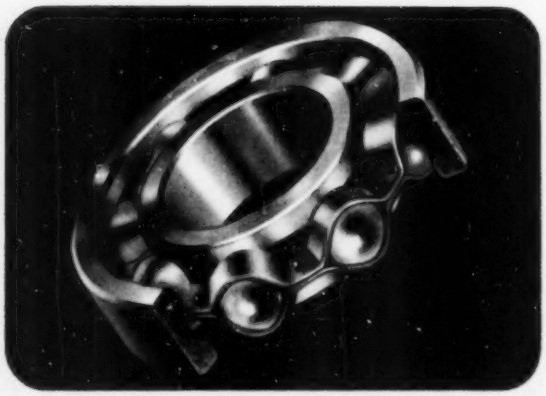
Tri-Clad extra lubrication "protection" can save you money because:

1. Tri-Clad's oversize grease reservoir and the heaviest standard-service bearings mean you do not have to bother with greasing between motor check-ups.

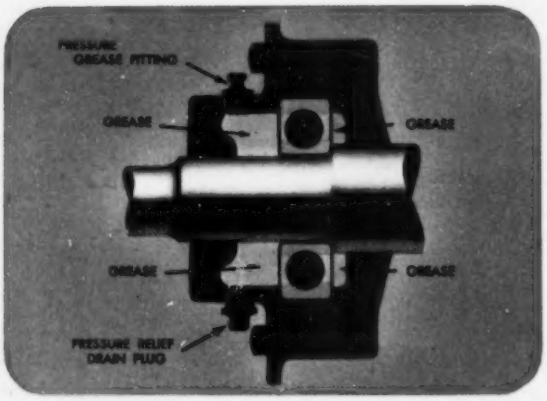
2. When relubrication is needed on those tough applications, you can grease a Tri-Clad without interrupting production-line operations.

Tri-Clads are grease-gun easy to lubricate *on the job*. Moreover, a Tri-Clad motor will run safely where an ordinary motor would fail. Chances are you'll be spared the cost of a "special" motor.

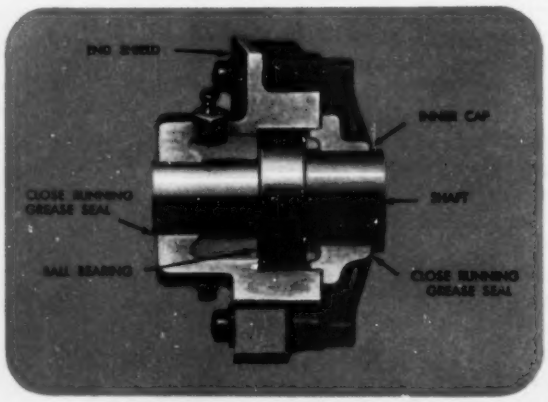
YOU BE THE JUDGE! The best way to prove to yourself that Tri-Clad gives you the most for your motor dollar is to contact your local G-E office. Tri-Clad stocks are complete. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*



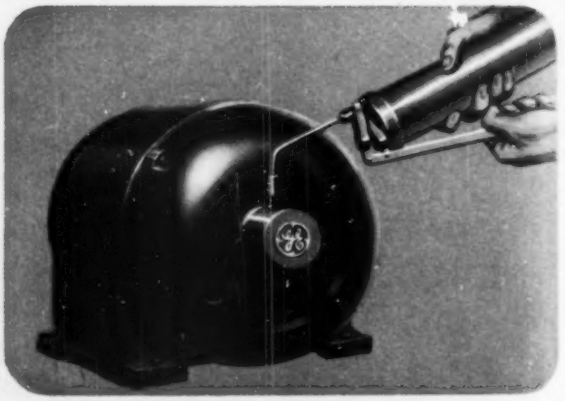
1 **EXTRA BEARING PROTECTION** — Tri-Clad gives you extra bearing protection because heaviest standard-service bearings are carefully selected to withstand severe loads for long periods.



2 **EXTRA GREASE** — Four times the ordinary amount of grease is packed into the large Tri-Clad grease reservoir. Since bearing life depends on grease, this means that Tri-Clad motors will run safely for years — for as long as any general-purpose motor you can buy.



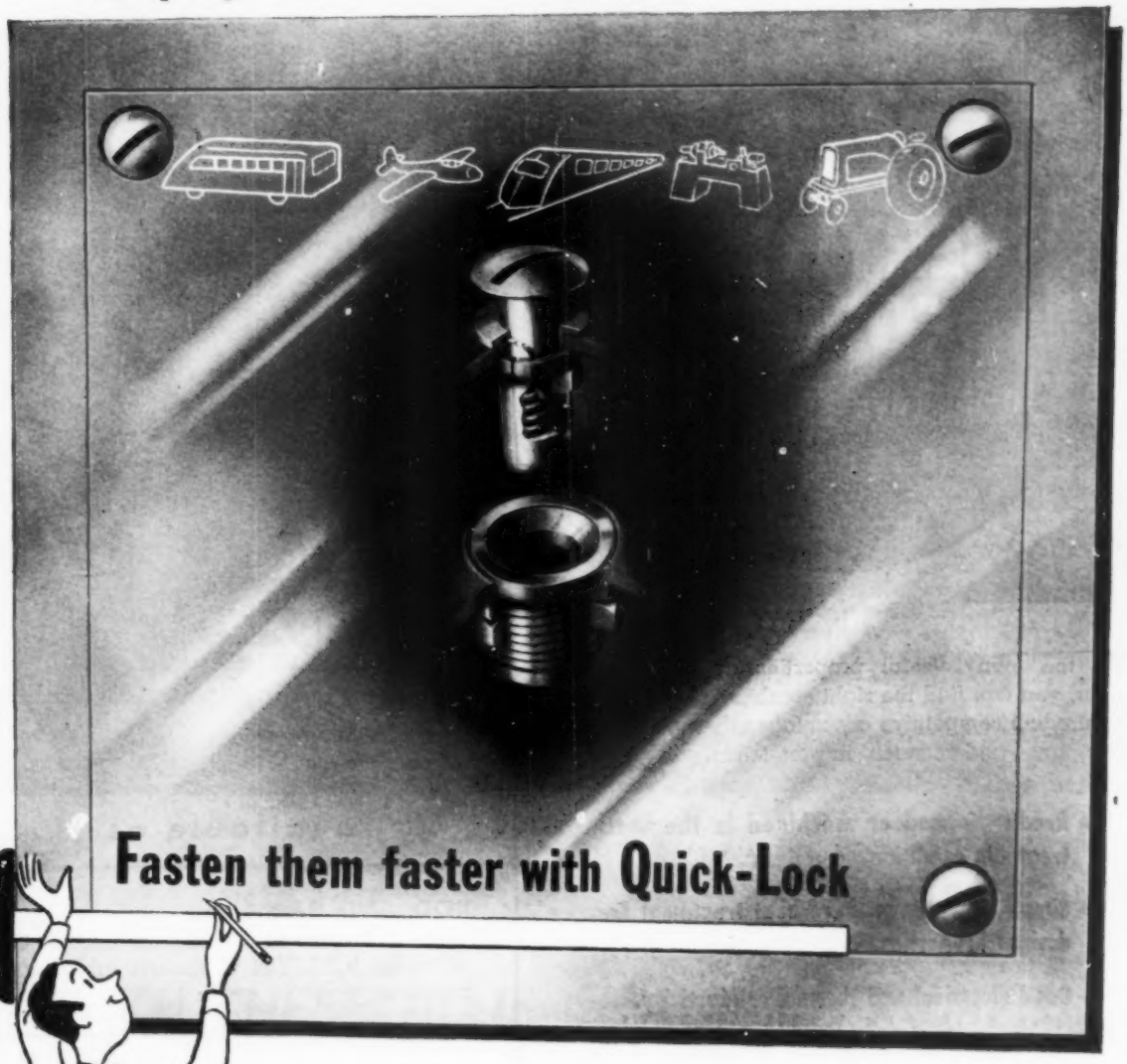
3 **SEALED-IN BEARINGS** — Bearings and grease are completely sealed in a cast housing with *long* running seals for extra protection from dirt, dust, and lubricant leakage.



4 **PRESSURE-RELIEF GREASING** — An efficient system of pressure-relief lubrication (with standard fittings) enables a Tri-Clad motor to be quickly and easily greased on the job when and if it's needed.

GENERAL ELECTRIC

Simplify Your Access Panel and Door Assemblies...



Fastening removable access doors and panels need not be a laborious and costly production or assembly operation—not if they're fastened with QUICK-LOCK.

Designed for simple installation, QUICK-LOCK requires no special tools. It speeds up mounting and demounting detachable panels with only a 90° turn required to lock and unlock it *in a jiffy*.

The flexible mounting and tapered stud makes QUICK-LOCK ideal for assembling curved sheets and insures a tight fit when locked. Stud is self-ejecting when unlocked. Minimum deflection is assured—only initial loads are carried by the helical spring. Solid supports take up increased loads.

Industrial and agricultural equipment manufacturers would do well to analyze the cost-saving features of QUICK-LOCK's simple design. A good way would be to call in a Simmons Engineer and discuss the economy of a QUICK-LOCK installation as compared to your present fastening method. Why not send for him today?

SIMMONS FASTENERS

SIMMONS FASTENER CORPORATION • 1751 NORTH BROADWAY, ALBANY 1, N. Y.

Things you should know about

BERYLLIUM COPPER

to improve performance—to reduce cost.

From the many useful properties of beryllium copper, you can find the right combination to give your product competitive advantages through high performance and economy in production.

- **Readily formed or machined in the heat-treatable condition.**
- **Simple, low-temperature heat treatment for desired properties.**
- **Good electrical and thermal conductivity.**
- **High elastic and endurance strength.**
- **Non-magnetic.**
- **Minimum drift and hysteresis.**
- **Excellent resistance to corrosion and corrosion fatigue.**

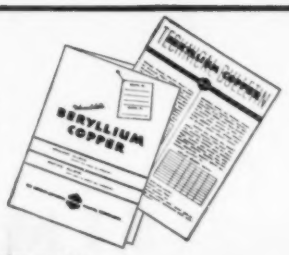
available as

ROD AND BAR
Rounds, Rectangles, Hexagons and others. Write for BULLETIN 13 for available forms and sizes.

WIRE
Heat-treatable and pretempered. Detailed information furnished on request.

STRIP
in Rolls or Lengths. Send for Bulletin 12 for full particulars.

HELPFUL ENGINEERING INFORMATION contained in a new series of Beryllium Copper Technical Bulletins. If you wish to receive these regularly, write us a note on your company letterhead.



BERYLCO BERYLLIUM ALLOYS

THE BERYLLIUM CORPORATION
DEPT. 9, READING 2, PA.
Offices in New York, Springfield (Mass.), Cleveland, Dayton, Detroit, Chicago, Minneapolis, Seattle, San Francisco, Los Angeles • Representation in principal foreign countries

STERLING INC., Milwaukee, manufacturers of *"Sterlco"* heating specialties and vacuum and condensate return units has used *Electrifugal* pumps for the past 15 years.

According to their President, Paul A. West, *"Electrifugal* pumps are compact, require a lot less space than separate motors and pumps. And, because they don't have to be aligned, they are easier to install. We find that we are able to design smaller overall-size units with these pumps. As for operating dependability, we *know* they stand up under long service. One of our customers operating a dual vacuum pump unit, reports over 12 years of continuous 24-hour-a-day duty cycle operation — no trouble of any sort."

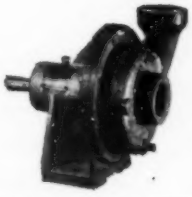
Save Space..Cut Design Costs

WITH THESE ALLIS-CHALMERS PUMPS!

2. COOLANT PUMPS

Foot-mounted, submerged, and side wall mounted types... sizes from 1 in. x ¾ in. to 1½ in. x 1½ in. Unit shown is side wall vertically mounting type — used extensively on broaches, drills, lathes, milling machines. Check coupon for information on complete Allis-Chalmers Coolant Pump line.

3. PEDRIFUGAL PUMPS



Pedestal-type pump that can be direct or *Texrope* V-belt driven for varying capacity and head. Five sizes handle all general pumping requirements to 500 gpm, heads to 110 ft. Pre-lubricated bearings require no further attention for three to five years. Check coupon for more information about *Pedrifugal* pumps.

Texrope, Electrifugal and *Pedrifugal* are Allis-Chalmers Trademarks.

ALLIS-CHALMERS

ALLIS-CHALMERS, 1002A SO. 70 ST, MILWAUKEE, WIS.

Gentlemen: Please send me information on:

- ☐ *Electrifugal* Pumps — 5286140A
- ☐ Coolant Pumps — 5286975
- ☐ Pedrifugal Pumps — 5286691

Name

Title

Firm

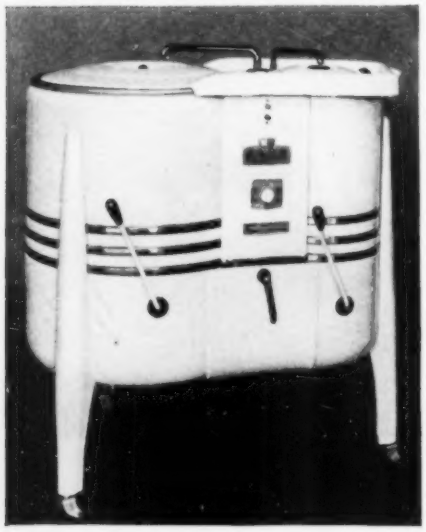
Address

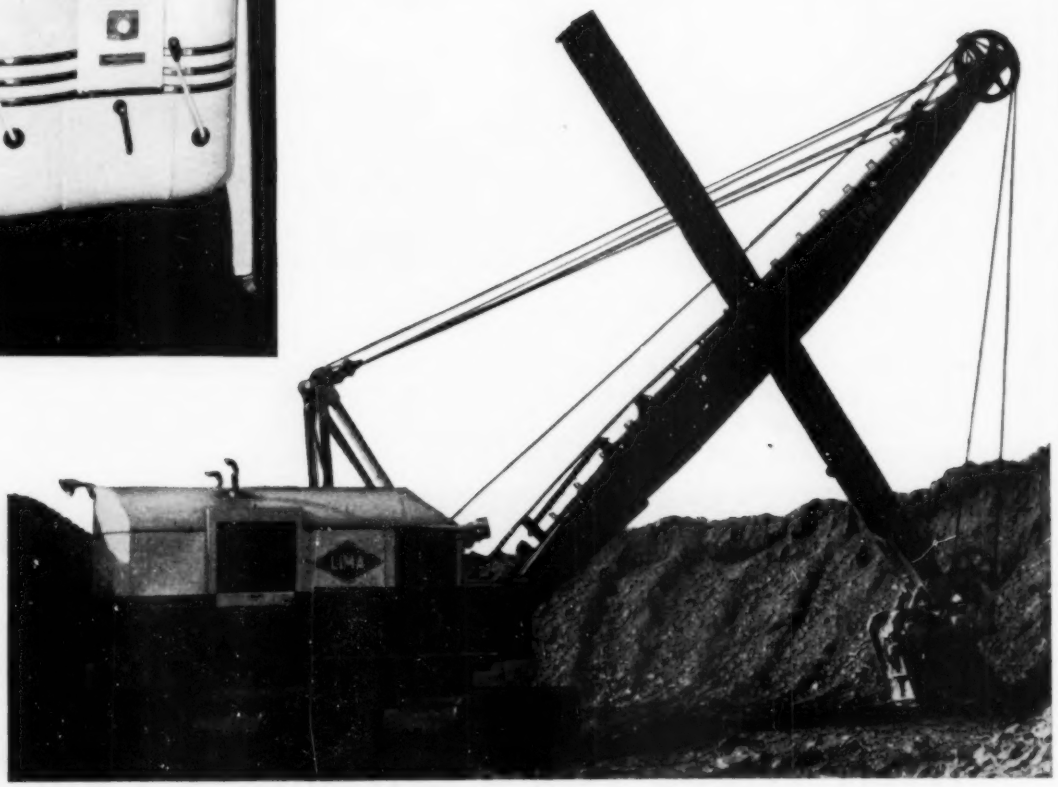
City State

A-2958

SOLD AND APPLIED BY AUTHORIZED DEALERS, AND DISTRICT OFFICES THROUGHOUT U. S., SERVICED BY CERTIFIED A-C SERVICE SHOPS

SAVE STEEL by using MAYARI R





A considerable tonnage of steel is being saved in various manufactured and fabricated products by the use of Mayari R in place of ordinary carbon steel. Mayari R goes farther because its substantially higher yield point permits it to be used in thinner-than-ordinary gages without sacrificing strength, corrosion-resistance, impact-resistance or any other essential properties.

Besides saving steel, the use of Mayari R helps in improving the design of many products. It often allows an appreciable reduction in deadweight that in turn cuts the cost of operation and maintenance.

Although it is a low-alloy, high-strength steel with superior properties, Mayari R can be worked and welded by the usual methods using ordinary shop equipment. It requires no heat-treatment and is used in the as-rolled condition.

You can find out more about this versatile steel and its advantages from any of our sales offices. Write or phone for a copy of Catalog No. 259.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

★ BETHLEHEM STEEL ★

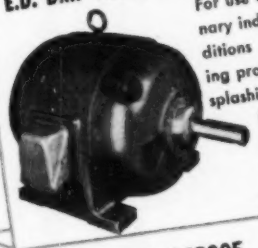
Mayari R *makes it lighter... stronger... longer lasting*

Give 'Em Tough Jobs— They Can Take It!

ED Motors Are Extra Rugged, Extra Dependable at the Windings

The windings are "the heart of the motor". And Electro Dynamic industrial motors are truly "stout-hearted" motors—rugged, durable, dependable. For E.D. windings are made with extra care, special skills and superior insulating materials—lessons learned in the tough job of building motors for marine use.

E.D. DRIP PROOF INDUSTRIAL MOTOR

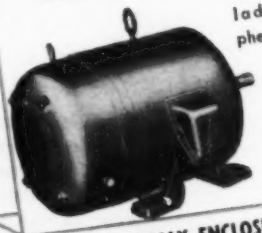


For use under ordinary industrial conditions not requiring protection from splashing liquids or from atmosphere laden with dirt or metal chips.

SPLASH PROOF

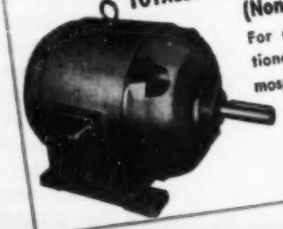
For installation where the motor is subjected to splashing liquids or hosing down for cleaning.

TOTALLY ENCLOSED (Fan Cooled)



For use in dirt-laden atmospheres, especially where the installation requires a motor of compact dimensions.

TOTALLY ENCLOSED (Non-Ventilated)



For use in exceptionally dirty atmospheres, particularly when metallic dust is present.

How You Benefit from E.D.'s Marine Experience

For many decades E.D. motors have been specified by naval architects and engineers for shipboard installations that require great stamina and unquestioned reliability. Year after year, as standards set by shipbuilders became more rigid, Electro Dynamic has stayed ahead by constantly improving motor designs, materials and manufacturing methods. Today the priceless lessons learned in this strict school are being applied to turning out great E.D. *industrial* motors. You get the full advantage when you specify E.D.

A Wide Range of Types, Sizes — All Competitively Priced

E.D. industrial motors are built in a wide range of types and sizes—1 to 250 h.p. And they're all competitively priced! Before you specify *any* motor, be sure to investigate E.D. Write today for illustrated literature.

Also a Complete Line of DIRECT CURRENT Motors and Generators. Literature on Request.

Industry has learned what marine engineers have known since 1880

ELECTRO DYNAMIC builds great motors

ELECTRO DYNAMIC • Division of the Electric Boat Company • Bayonne, N. J.

ANOTHER Machine Tool Made Better with MEEHANITE® *Castings*

(Fig. 1)

The modern streamlined production tools like the Super Service Uprights (Fig. 1), manufactured by Cincinnati Bickford Tool Company, Cincinnati, Ohio, are built with many Meehanite castings. All of the truly *vital* castings are Meehanite metal. A few are illustrated.

In the manufacture and sale of a machine tool of this type it is a long road between the drawing board and the customers' production floor. The correct specification of proper materials for component parts to translate maximum design superiority into product superiority, is of major importance. That is why wherever quality products are built; where better engineering properties combined with uniformity and repeated dependability are required,—Meehanite castings are specified and insisted upon.

Take advantage of Meehanite engineering service—send your blueprints for analysis and specific recommendation to the foundries listed below.

Take Your Casting Problems To A MEEHANITE Foundry!

American Brake Shoe Co.	Mahwah, New Jersey
The American Laundry Machinery Co.	Rochester, New York
Atlas Foundry Co.	Detroit, Michigan
Banner Iron Works	St. Louis, Missouri
Barnett Foundry & Machine Co.	Irvington, New Jersey
E. W. Bliss Co.	Hastings, Mich. and Toledo, O.
Builders Iron Foundry, Inc.	Providence, Rhode Island
Continental Gin Co.	Birmingham, Alabama
The Cooper-Bessemer Corp.	Mt. Vernon, Ohio and Grove City, Pa.
Farrel-Birmingham Co., Inc.	Ansonia, Connecticut
Florence Pipe Foundry & Machine Co.	Florence, New Jersey
Fulton Foundry & Machine Co., Inc.	Cleveland, Ohio
General Foundry & Manufacturing Co.	Flint, Michigan
Greenlee Foundry Co.	Chicago, Illinois
The Hamilton Foundry & Machine Co.	Hamilton, Ohio
Johnstone Foundries, Inc.	Grove City, Pennsylvania
Kanawha Manufacturing Co.	Charleston, West Virginia
Koehring Co.	Milwaukee, Wisconsin
Lincoln Foundry Corp.	Los Angeles, California
E. Long Ltd.	Orillia, Ontario
Otis Elevator Co., Ltd.	Hamilton, Ontario
The Henry Perkins Co.	Bridgewater, Massachusetts
Pohlman Foundry Co., Inc.	Buffalo, New York
The Prescott Co.	Menominee, Michigan
Rosedale Foundry & Machine Co.	Pittsburgh, Pennsylvania
Ross-Meehan Foundries	Chattanooga, Tennessee
Shenango-Penn Mold Co.	Dover, Ohio
Sonith Industries, Inc.	Indianapolis, Ind.
Standard Foundry Co.	Worcester, Massachusetts
The Stearns-Roger Manufacturing Co.	Denver, Colorado
Traylor Engineering & Mfg. Co.	Allentown, Pennsylvania
Valley Iron Works, Inc.	St. Paul, Minnesota
Vulcan Foundry Co.	Oakland, California
Warren Foundry & Pipe Corporation	Phillipsburg, New Jersey

"This advertisement sponsored by foundries listed above."

MEEHANITE® PERSHING SQUARE BUILDING • NEW ROCHELLE, N. Y.

Another Goodyear First—

A new cord material that gives V-Belts

40% higher HP ratings Highest shock-load resistance without excessive stretch

HEART of these belts is a new, chemically produced fiber that has nylon's *strength, without its stretch.* This newly developed material is the reason why HY-T Multi-V-Belts boast horsepower ratings 40% above ordinary belts.

That means you can handle heavier loads with fewer belts—7 HY-T belts will walk away with a load that requires 10 regular belts! What's more, they're built to take heavy shock-loads in stride—give outstanding flex-life on *all* diameter sheaves, and at all speeds within Goodyear or RMA recommendations.

Now V-Belt users everywhere can get the ideal combination of characteristics for heavy-duty, high-shock-load service with Goodyear's NEW HY-T belts. Designed to meet the most exacting requirements—tested on hundreds of tough drives—these belts are now in production and will soon be available in standard sizes through your nearest Goodyear Industrial Rubber Products Distributor.

Ask the G.T.M.—Goodyear Technical Man—or your nearest Goodyear Distributor to show you how to end your drive problems with this new belt that has the highest HP rating and longest flex-life of any fiber construction belt on the market. Or write Goodyear, Akron 16, Ohio.

You get all nine with Goodyear's NEW HY-T Multi-V-Belts

- HIGHER HP RATING
- REDUCED STRETCH
- LONG FLEX-LIFE
- HIGH SHOCK-LOAD RESISTANCE
- COOL RUNNING
- OIL RESISTANCE
- RESISTS AGING
- STATIC CONDUCTION
- MILDEW RESISTANCE

GOODYEAR INDUSTRIAL RUBBER PRODUCTS
GTM-Specified HY-T MULTI-V-BELTS
cross-section A, B and C sizes up to 120"
A—single plane of synthetic cords for greatest flexibility
B—cushion section of rubber
C—notches close rounding pulleys for more pull, open between pulleys for cool running
cross-section A, B, C, D and E sizes 120" and longer
a—multiple-ply synthetic-cord load carriers for maximum strength and shock resistance
b—fabric reinforced body to minimize vibration on longer drives
A
B
C
a
b

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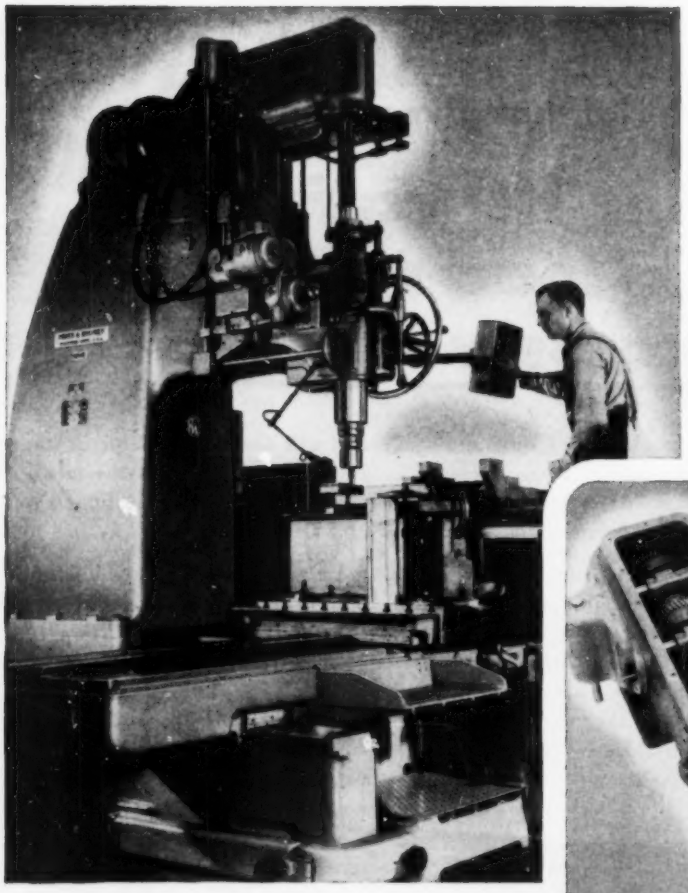

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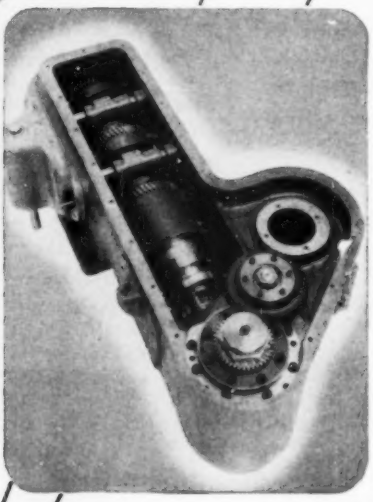

Pratt & Whitney Model 4E Jig Borer.

Inset: View of Twin Disc MTU Duplex Clutch in the gearhead.

. . . with a Twin Disc Clutch

It takes real *precision* to locate and bore holes with an accuracy of *.0002"*. But Pratt & Whitney's new Model 4E Jig Borer does it. A 15-ton example of accuracy, stability and fine workmanship, this machine utilizes a 4½" Twin Disc MTU Duplex Clutch and brake combination in the gearhead.

Built to "wear like a bearing and perform like the best friction clutch" . . . that's the standard to which Twin Disc machine tool clutches are held. In addition to compactness, high torque capacity and long wear-life, Twin Disc Clutches feature ease of operation and single point adjustment. No wonder precision manufacturers like Pratt & Whitney think of Twin Disc when their design calls for *accuracy.*

For more information on Twin Disc Machine Tool Clutches see your nearest Twin Disc dealer or write for Bulletin No. 134-A.

TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES

Clutches & Hydraulic Drives

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin • HYDRAULIC DIVISION, Rockford, Illinois

BRANCHES: CLEVELAND • DALLAS • DETROIT • LOS ANGELES • NEWARK • NEW ORLEANS • SEATTLE • TULSA

this job...

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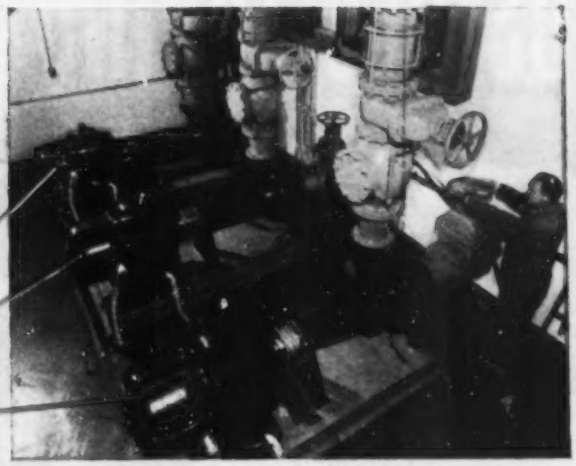
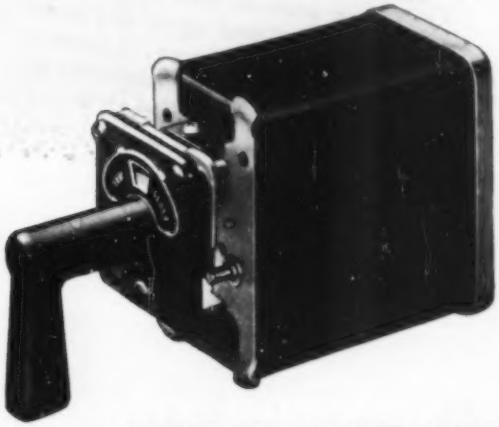


The Manhattan Beach pumping station of Los Angeles County South Bay Cities Sanitation District handles about two million gallons of sewage per day. The speed of its three 50-hp pump motors may be controlled automatically by a relay system or manually by three General Electric SB-1 switches. A fourth SB-1 switch selects either manual or automatic operation.

... easily done with the SB-1



CONTROL AND TRANSFER SWITCH
Rating up to 20 amp at 600 volts a-c or d-c

Standard parts and simple basic design of the SB-1 mean longer life and low initial cost to you. There's a *standard* SB-1 for most jobs—ready on six weeks delivery. A variety of switch handles with watertight, dust-tight, oil-immersed, fabricated metal, or explosion-proof housings are available to fit your installation problems. Why not try an SB-1 on your particular problem? For further details see your G-E sales representative and write for Bulletin GEA-4746. *Apparatus Dept., Section 856-73, General Electric, Schenectady 5, N.Y.*

GENERAL ELECTRIC

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For more strength, less weight, smooth modern beauty, and lower cost, product designers and manufacturers are turning more and more to steel tubing—and the big trend is to OSTUCO Tubing.

Ostuco's "Single Source Service" is the reason. By performing all three basic tubing operations—manufacturing, shaping, and fabricating—at one plant, Ostuco boosts quality and eliminates expensive, time-consuming shipments from one supplier or one location to another. Unified control of production assures precision in meeting your most exacting requirements; responsibility is clearly fixed.

Ostuco produces both seamless and electric welded steel tubing in a broad range of sizes and shapes . . . performs ALL types of forging and fabricating operations . . . supplies finished or semi-finished products. Write direct or to our nearest sales office for informative free booklet "Fabricating and Forging Steel Tubing."

From Your Blueprint . . . to Your Product

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✔ AlSiMag plates and discs can be produced FLAT within microinches.

✔ Some AlSiMag compositions have such great resistance to HEAT SHOCK that they are used in the control of molten metals.

✔ AlSiMag is one of the best ELECTRICAL INSULATORS at high temperatures and high frequencies.

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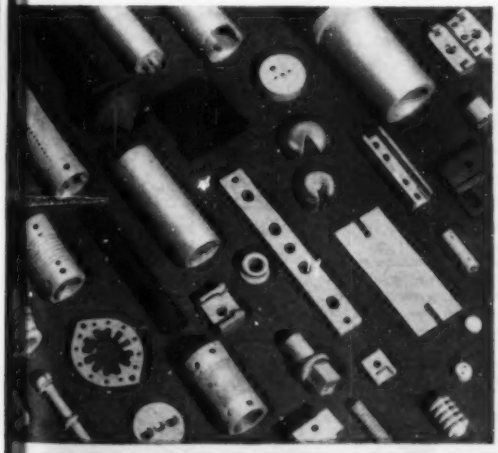
✔ AlSiMag tubes have been successfully produced with holes almost as small as a human hair, with wall sections of about the same thickness.

ALSIMAG
TRADE MARK REG. U.S. PAT. OFF.

✔ **Some AlSiMag precision made parts are so tiny that several thousand will go in a thimble.**
(For illustrative purpose, larger parts are shown here.)



• AlSiMag Custom Made Technical Ceramics are available in a wide variety of physical characteristics. AlSiMag parts come to you ready for your assembly line. They are uniform, dimensionally accurate and economically fabricated in quantity. American Lava Corporation is known throughout the industry for its leadership in engineering and research and for its ability to produce ceramics that comply with specifications and that do the job as planned. Engineering cooperation and handmade test samples are available. Send us your problems.

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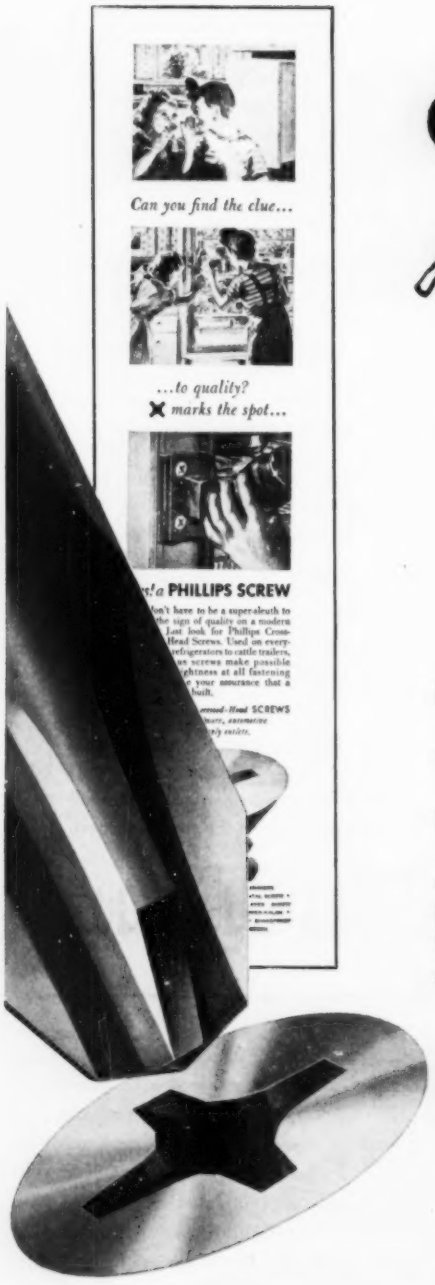

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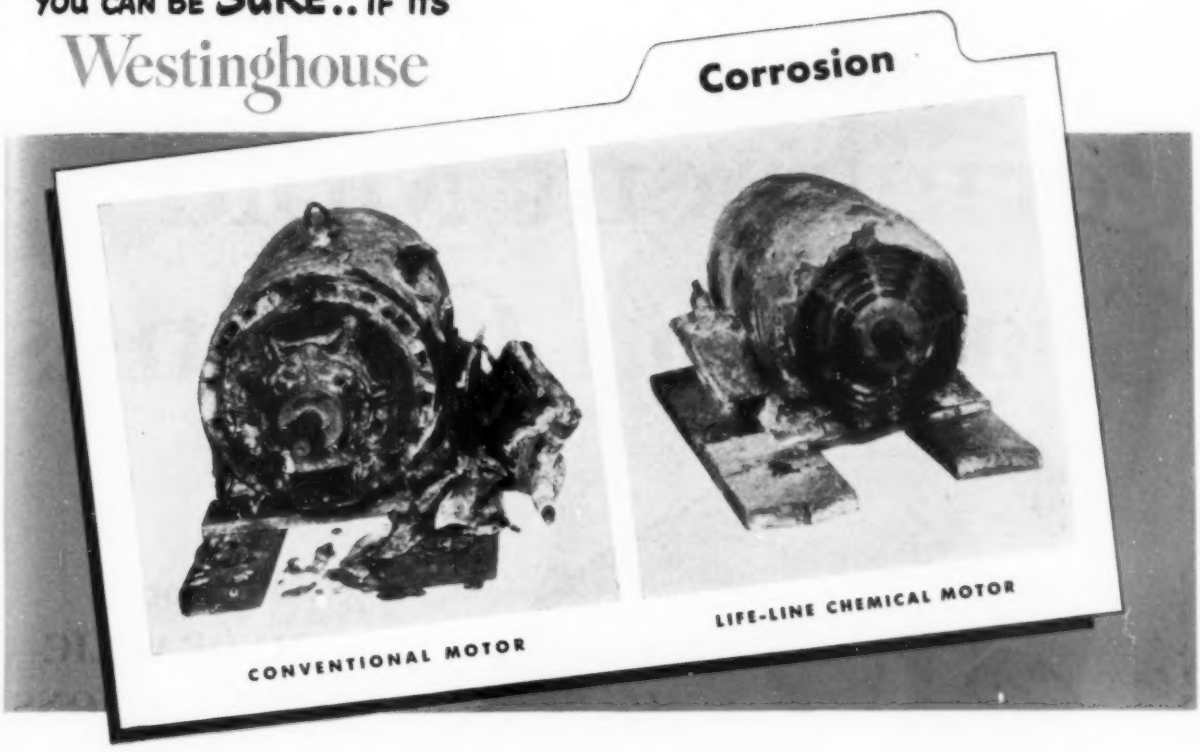

60-Week Corrosion Battle Proves *Life-Line* Chemical Motor Easy Winner

Two motors—one a CS cast-iron motor, accepted by industry as the best available for chemical service; the other a Life-Line all-steel chemical motor—were placed in a salt spray tank July, 1947. 10,007 hours later (approximately 60 weeks) they were removed. The unretouched photographs offer visual proof of the Life-Line chemical motor's superiority.

This Life-Line chemical motor offers more protection against corrosion than any motor we've ever built. It's protected at every point.

Frames, brackets, feet are Bonderized; then given four protective coatings. The first is a formaldehyde alkyd-type enamel, well known for its superior corrosion resistance. To assure perfect bonding, it is baked for 30 minutes at 250° F. Two dips and bakes of tough, flexible Thermoset varnish are then applied. Finally, the exterior finish coat of gray lacquer is sprayed on.

Stator windings, too, are double dipped and baked in Thermoset. A bronze blower provides adequate cooling . . . stands up to tough corrosive atmospheres. Neoprene bearing seals are an added precaution. Bearings are factory-sealed and prelubricated . . . need no further lubrication.

These extras provide the kind of performance shown by the above example. Need something extra in a motor? Extra protection against corrosion . . . against outages from any cause? Check the Life-Line. Ask your Westinghouse representative for a copy of Chemical Motor B-4657, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21577

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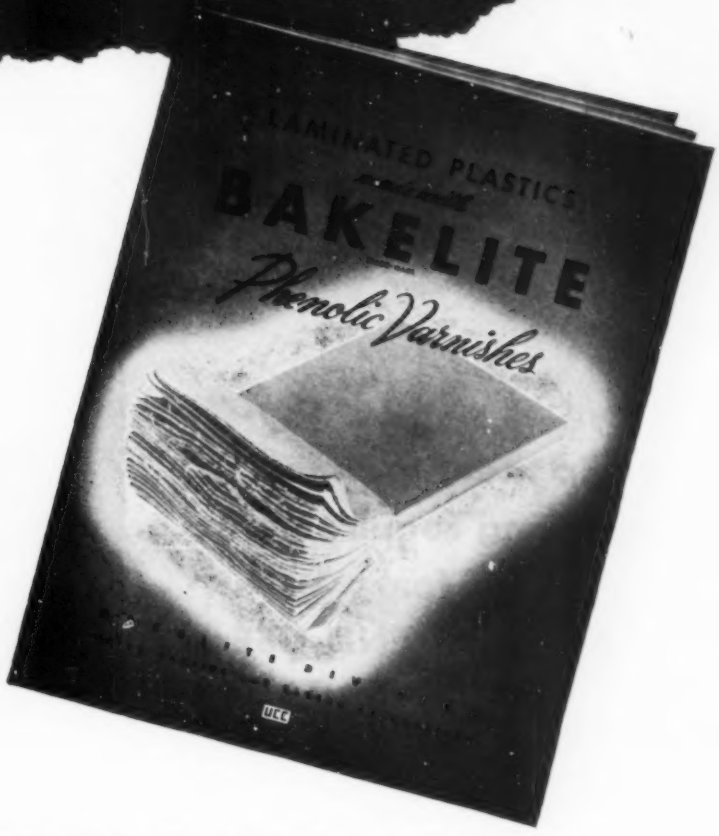

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GET MORE OUT OF METALS

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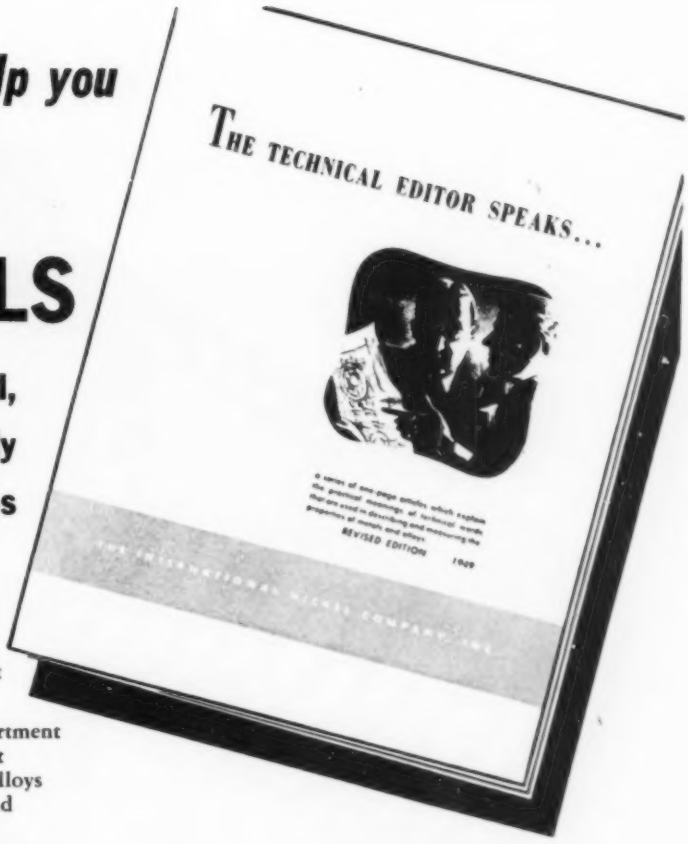

Here's a booklet that's a "must" for any one who chooses or uses metals.

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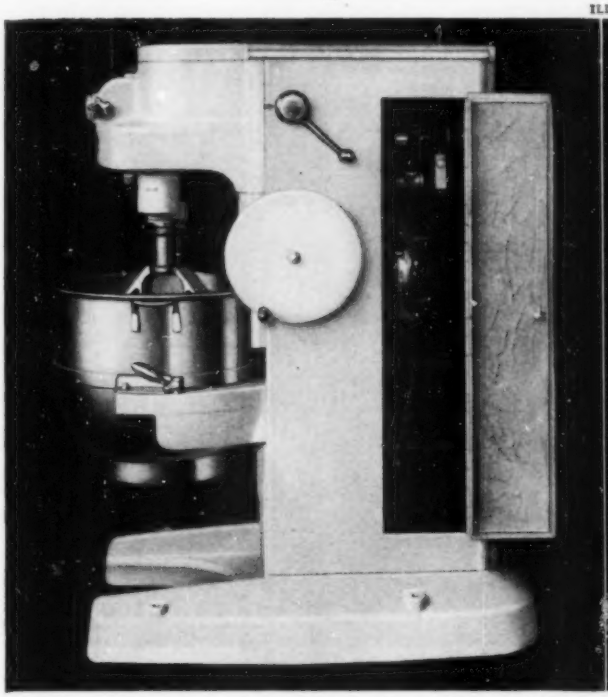
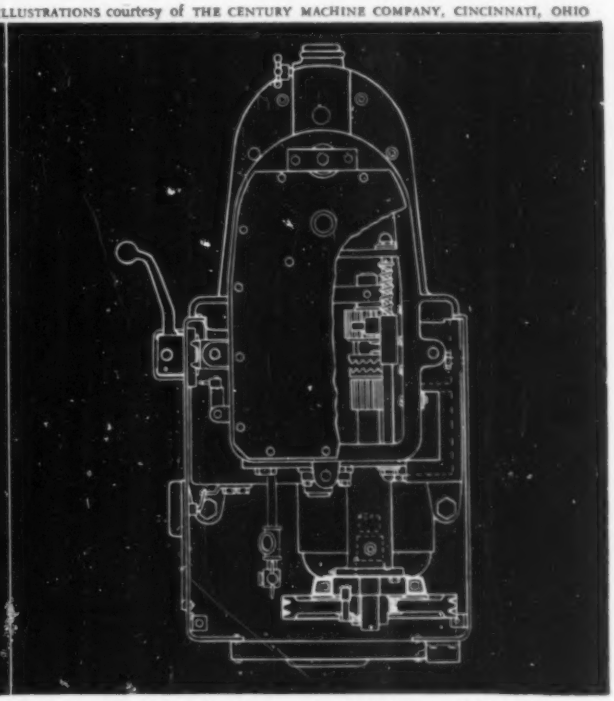
How A Warner "ICB" Unit Simplifies Control on a *Century* Vertical Dough Mixer

ILLUSTRATIONS courtesy of THE CENTURY MACHINE COMPANY, CINCINNATI, OHIO



Side view of vertical dough mixer. Note position of Warner "ICB" Electric Brake Unit next to drive sheave (top right) and single control lever (top center).



Top view drawing of dough mixer showing Warner "ICB" Brake Unit mounted on drive shaft next to sheave.

What Century says About the WARNER "ICB" Unit

Using a Warner "ICB" Unit on the Century Vertical Dough Mixer gives extremely simple quick-acting control. It enables us to make a single lever do the complete job of starting, stopping and speed selection.

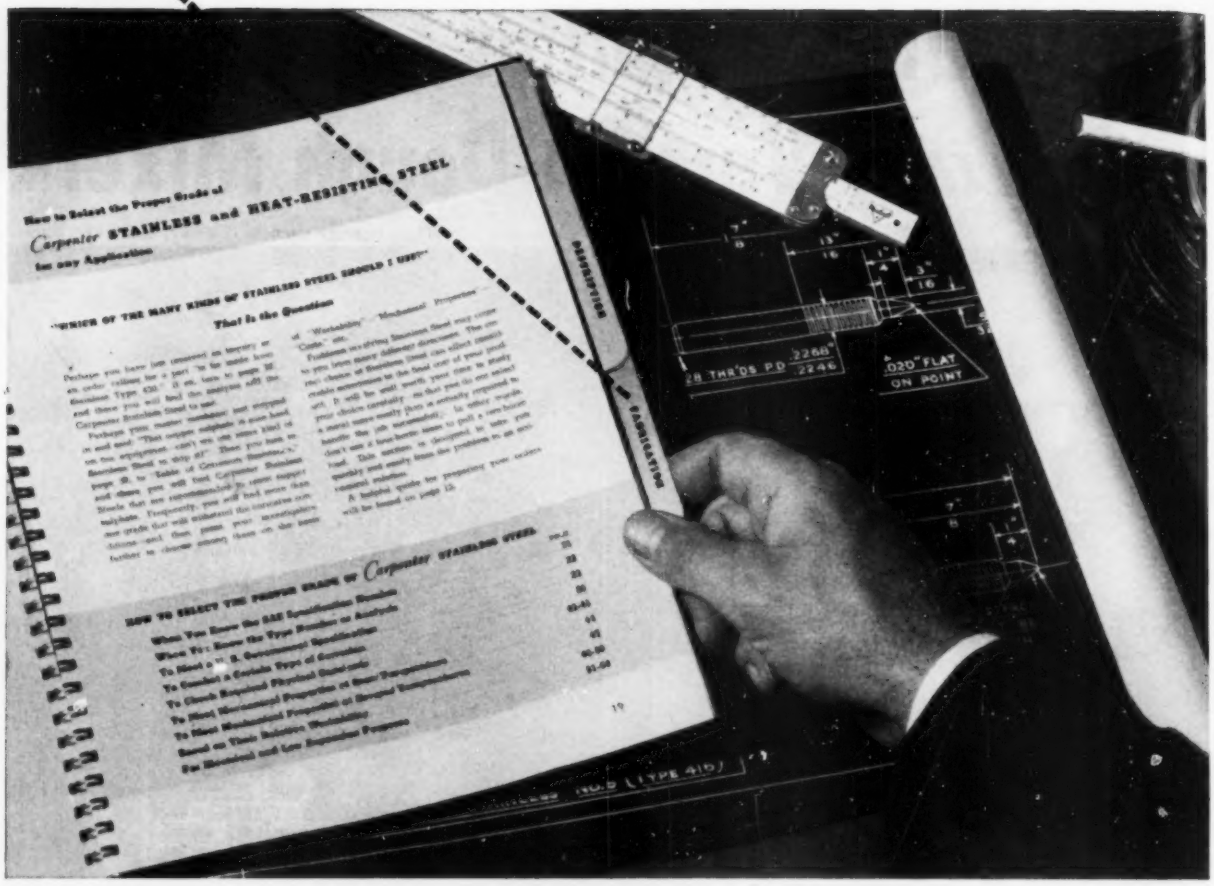
It also enables the use of positive tooth clutches without clashing when changing speeds. The operator has complete shifting control because the single lever simultaneously de-energizes the motor, energizes the Warner "ICB" Brake and disengages the clutch. Moving the lever to the desired speed position mechanically places the clutch teeth in position to engage. Release of lever simultaneously releases the Warner "ICB" Brake, energizes the motor and engages the clutch.

Warner "ICB" Units are electrically-powered, low-wattage clutches and brakes. They can be operated singly or in combination—automatically or by push-button control. Because they are electric—they give lightning-fast response. Because they are compact and simple, they provide easy installation and long-term dependable operation. They're a new answer to a wide variety of old machine design and operation problems. For further information on how Warner "ICB" Units may help you — write today to the WARNER ELECTRIC BRAKE & CLUTCH CO., Dept. PE, Beloit, Wisconsin.

WARNER
ICB UNIT

Warner ICB Units are manufactured by Warner Electric Brake & Clutch Co. — pioneers in the field of electric brake design and application since 1927.

X MARKS THE SPOT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for any Application
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That Is the Question
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To Meet a U. S. Government Specification
To Combat a Certain Type of Corrosion
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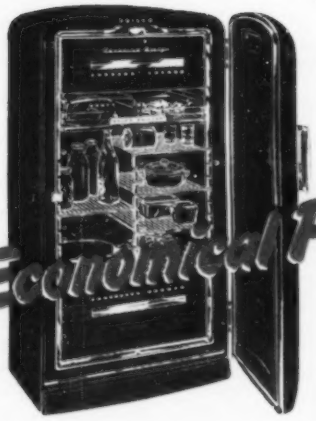

For Economical Plastics Parts* Production ON LONG-RUN JOBS

* General Electric molds plastics snack boxes, freezer doors, and meat trays for handsome new Philco refrigerators. These plastics units are light in weight, extremely durable, and easy to keep clean.

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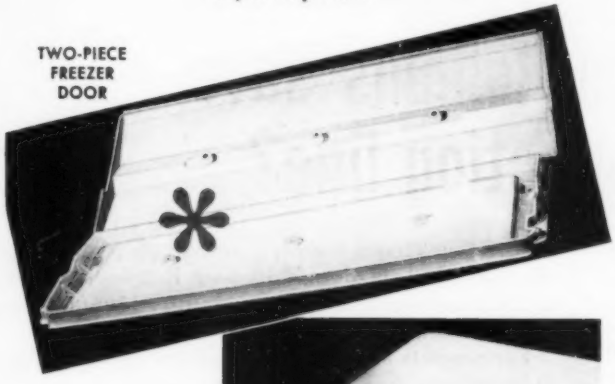
General Electric has had years of experience in custom molding products and parts for the appliance field, where large-volume runs and large-size parts are common. G.E. can economically produce big parts like crisper boxes for refrigerators, washing machine agitators, front panels and louvers for room coolers, fan bases and motor housings, radio and television cabinets.

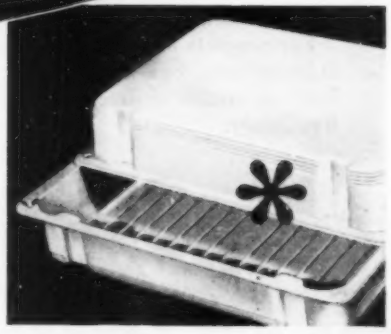
General Electric's modern molding plants, strategically located in the East and Midwest provide fast delivery on all types of plastics molding and extruding.

HOW CAN YOU BENEFIT FROM G.E.'s PLASTICS MOLDING SERVICE? Write us on your company letterhead for information and for a free copy of the interesting booklet, "Your Plastics Dollars Worth." It may save *you* money. Department Y3, General Electric Company, 1 Plastics Avenue, Pittsfield, Mass.

TWO-PIECE FREEZER DOOR



MEAT TRAYS



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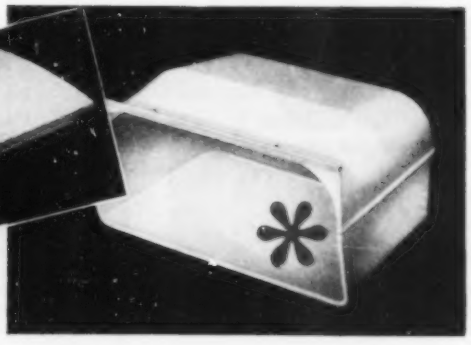

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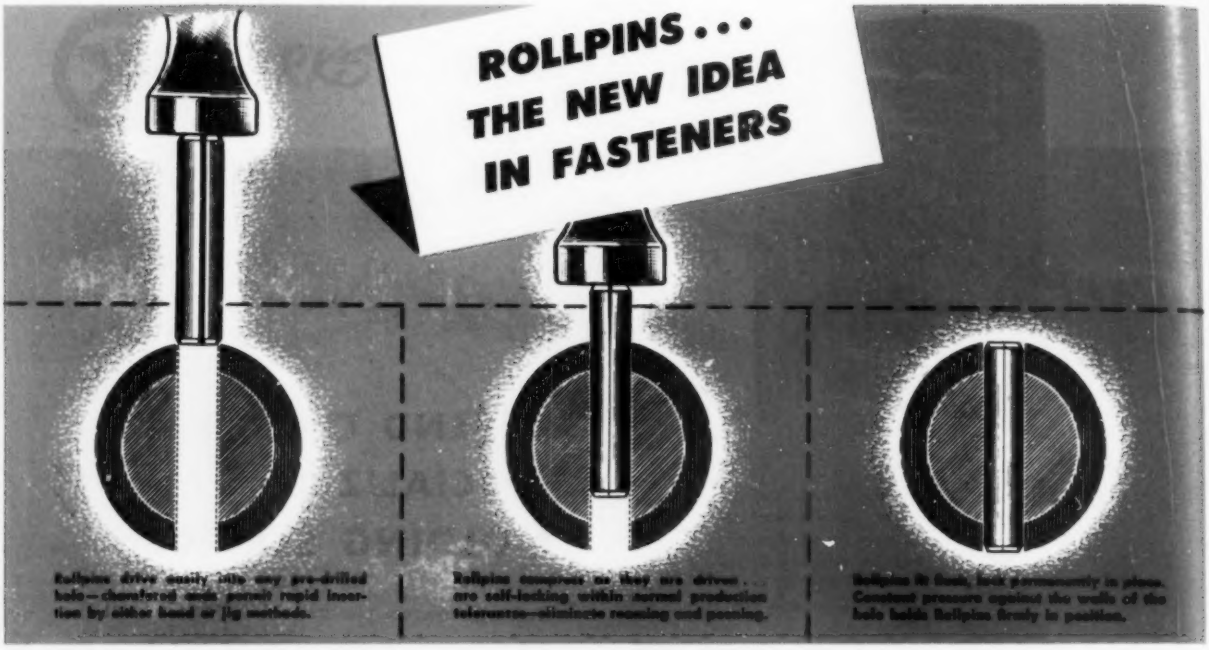

How much can Rollpins save on your production line?

Here's important information on Rollpins—the amazing new fasteners that eliminate slow, expensive reaming, peening, and machining operations. Just imagine the cost-cutting possibilities provided by a single fastener with such wide design and application flexibility that it can replace tapered pins, grooved pins, or straight pins. Investigate the savings Rollpins offer *your* product.

In the short period since their introduction, manufacturers are already using Rollpins as steel fastening pins holding pulleys and gears to shafts; as pivot or hinge pins, clevis pins, cotter keys, shafts, and locating dowels . . . to provide lower-cost, simplified, vibration-proof assemblies.

Rollpins require no special installation skills . . . readily replace your present fastener . . . exceed the sheer strength of a cold-rolled pin of equal diameter. Rollpins stay tightly in place until deliberately removed with a pin punch—can be used over and over again.

For complete information on Rollpins and their almost unlimited money-saving applications write to Elastic Stop Nut Corporation of America, 2330 Vauxhall Road, Union, New Jersey.

ROLLPIN
A PRODUCT OF

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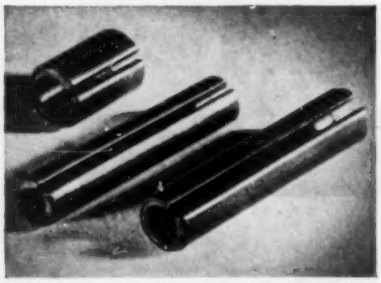
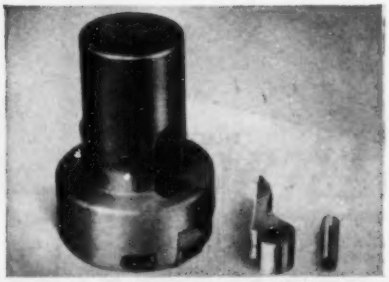
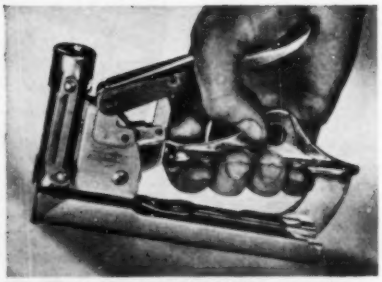
ELASTIC STOP NUT CORPORATION OF AMERICA



Rollpins are made from either Carbon Steel or Stainless Steel and are readily available from stock in diameters from 1/16 inch to ½ inch and in a broad range of standard lengths.



Rollpins are used to replace a hardened, ground tapered pin in this feed tube finger clutch assembly—stand up to flexing and shock more than 2,400 times an hour.



Four Rollpins are used in this Hansen tacker as pivots. Self-retaining, they eliminate headed rivets and bolts . . . simplify maintenance operations . . . provide a flush fit.

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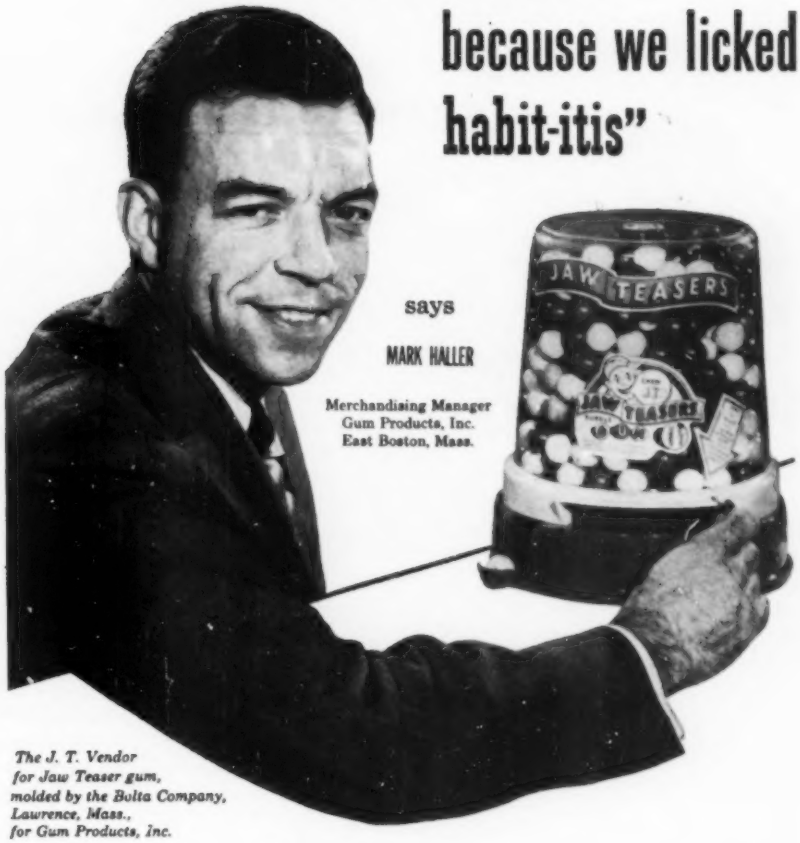

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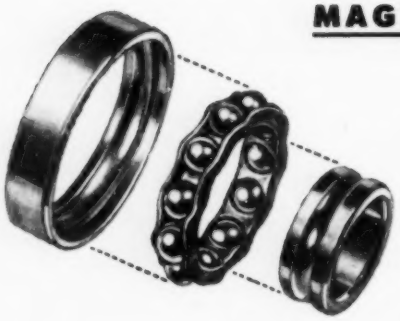

Intermittent or continuous high speed operation, with moderate radial and thrust loads, are typical operating conditions for Federal Magneto, or "Separable," Type Ball Bearings.

These bearings are easily separated into three parts: outer ring, inner ring and the spacer with balls, making possible rigid mounting of either or both rings before assembly. Separate mounting helps to eliminate the possibility of slippage, looseness, vibration and noise. The removable outer ring permits the use of a maximum number of balls, thereby increasing the load-carrying capacity of the bearing. When mounted in pairs, radial, thrust or combined loads may be applied.

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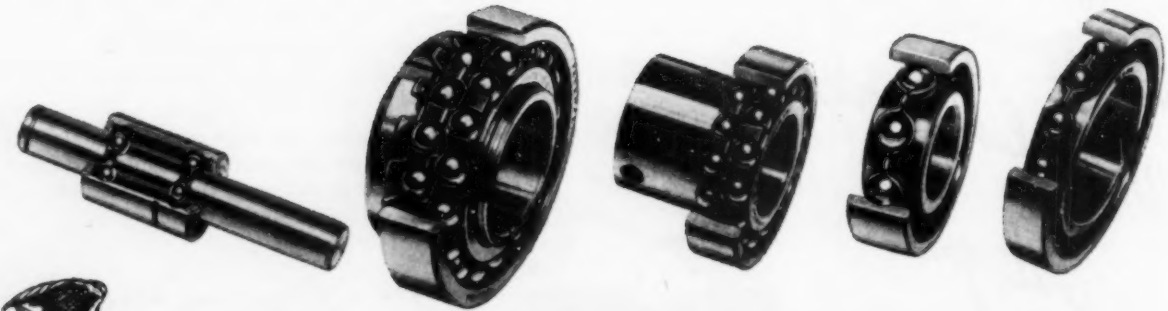

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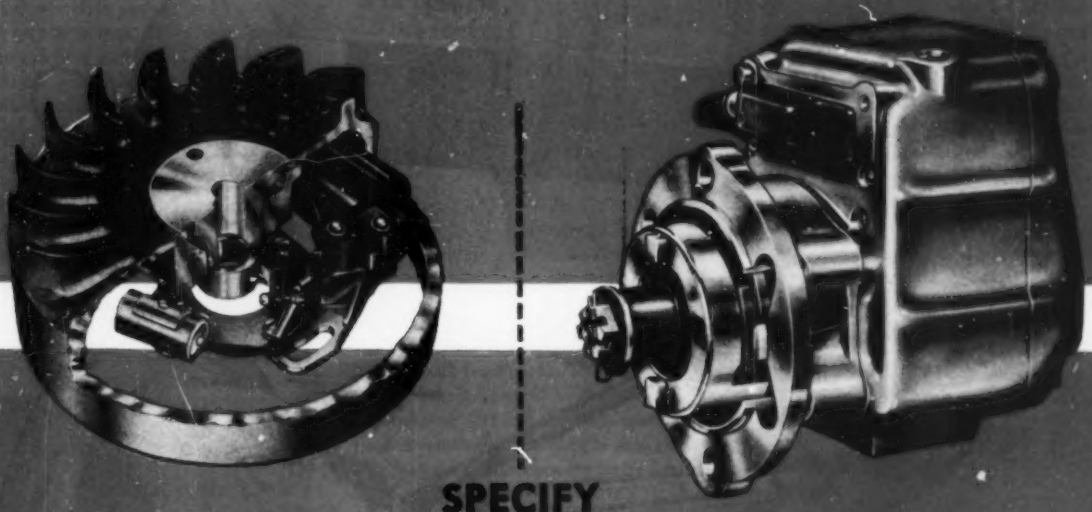

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Valve seat grinder poses two distinct oil sealing problems

Two unusual shaft sealing problems are present in the rotary valve seat grinder for large gasoline and diesel engines (Fig. 1). Rotary speeds from 300 to 12,000 rpm, shaft whip, reciprocating action and extreme external abrasive conditions require oil seals of unusual dependability.

In the sectional drawing (Fig. 1), the main shaft driving the abrasive wheel rotates at 12,000 rpm. This shaft also engages a secondary worm gear to rotate the entire grinder around the periphery of the valve seat. National 50,000-S Syntech (Fig. 2) seals, spring-loaded, single wipe units are installed just inside the pre-loaded ball

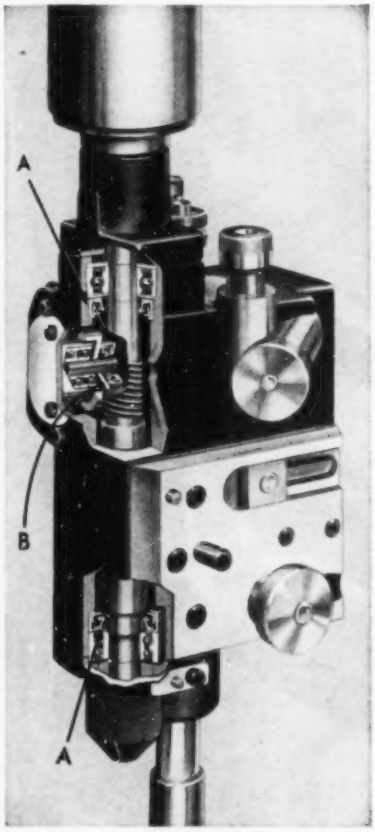

Figure 1

Figure 2

bearings (A) on the main shaft and outside the conventional bearing (B) on the horizontal shaft (in Fig. 1). These seals retain a light lubricating oil in the open double row bearing (B) and the high-speed worm gear. Even though flooding is encountered, zero leakage performance must be achieved to prevent flooding of the grinding wheel. The high speed and angle thrust on this spindle result in shaft whip, which demands flexibility in the oil sealing members. National Syntech* oil seals are ideal for this application, because their inherent flexibility and *carefully* designed flex section provide effective sealing under eccentricities up to .025 indicator reading. The minimum-contact, carefully tensioned sealing lip insures minimum drag and dependable sealing even under continued operation at high speeds.

Figure 3

The section (Fig. 4) is of a wheel dressing attachment. Here shaft action is reciprocative and extreme abrasive conditions are present since the assembly is continually exposed to fine abrasive dust from the grinding wheel. Two sturdy National Syntech 340,000 series (Fig. 3) are installed here. The seals are mounted with lips facing outward (C) and serve as dust excluders. Effectiveness of the seals is attested by the fact that with hundreds of grinders in operation, no replacement has yet been required due to scored shaft surfaces or abrasive leakage.

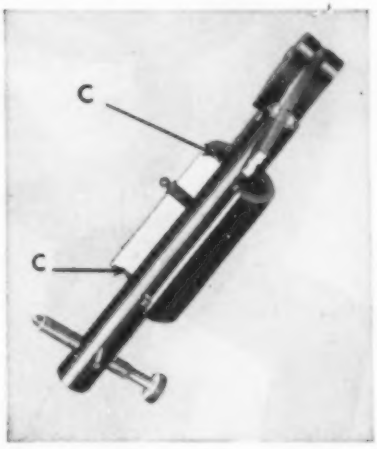

Figure 4

In many cases such as the above, sealing problems can be solved at considerable savings by using stock National Oil Seal designs. In other applications, special designs may be necessary. In either event, National Oil Seal engineers are ready to assist you.

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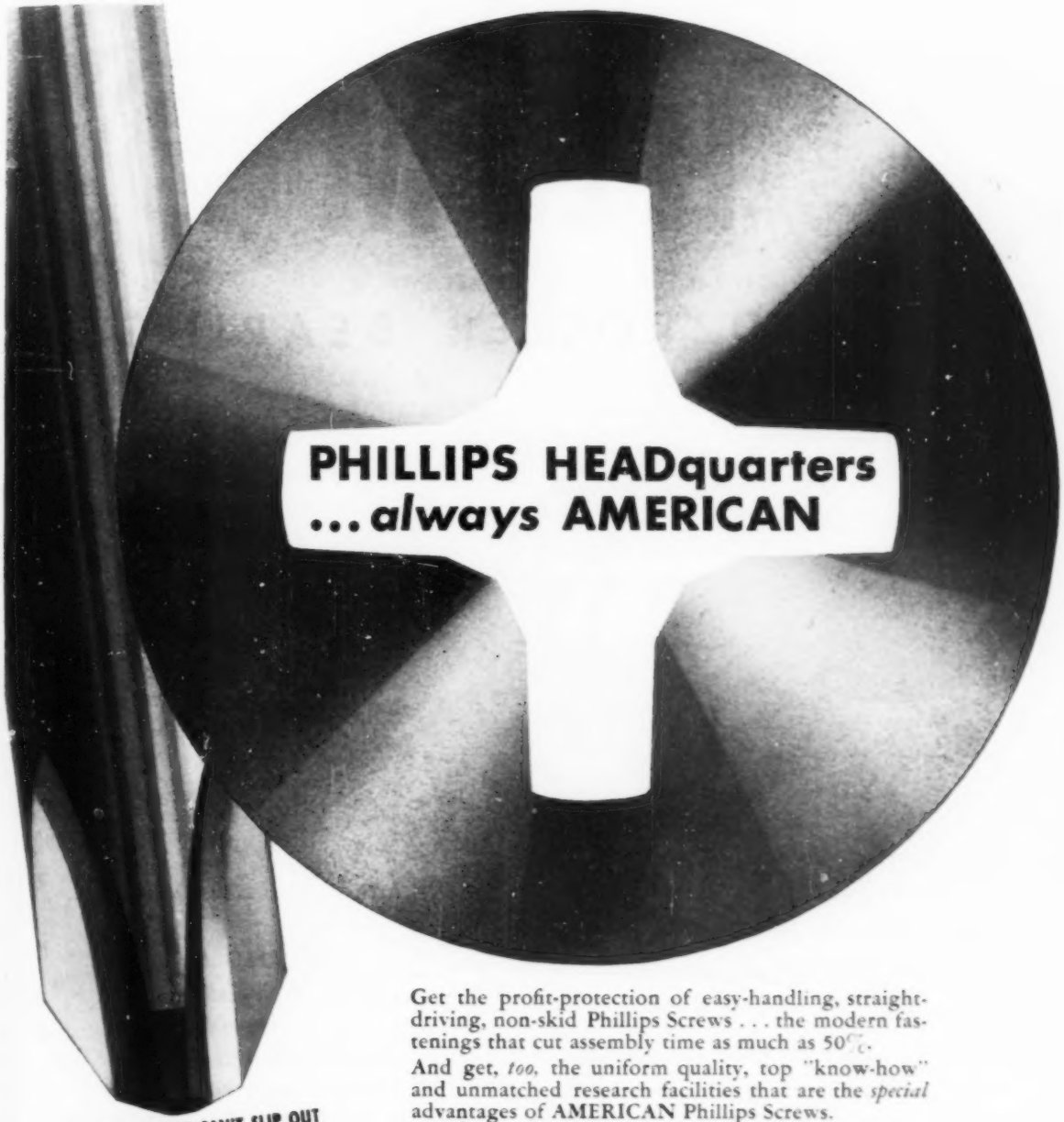

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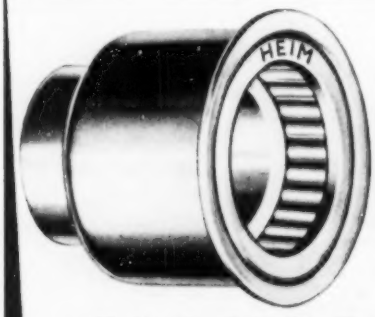

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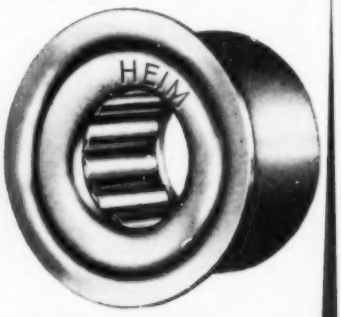

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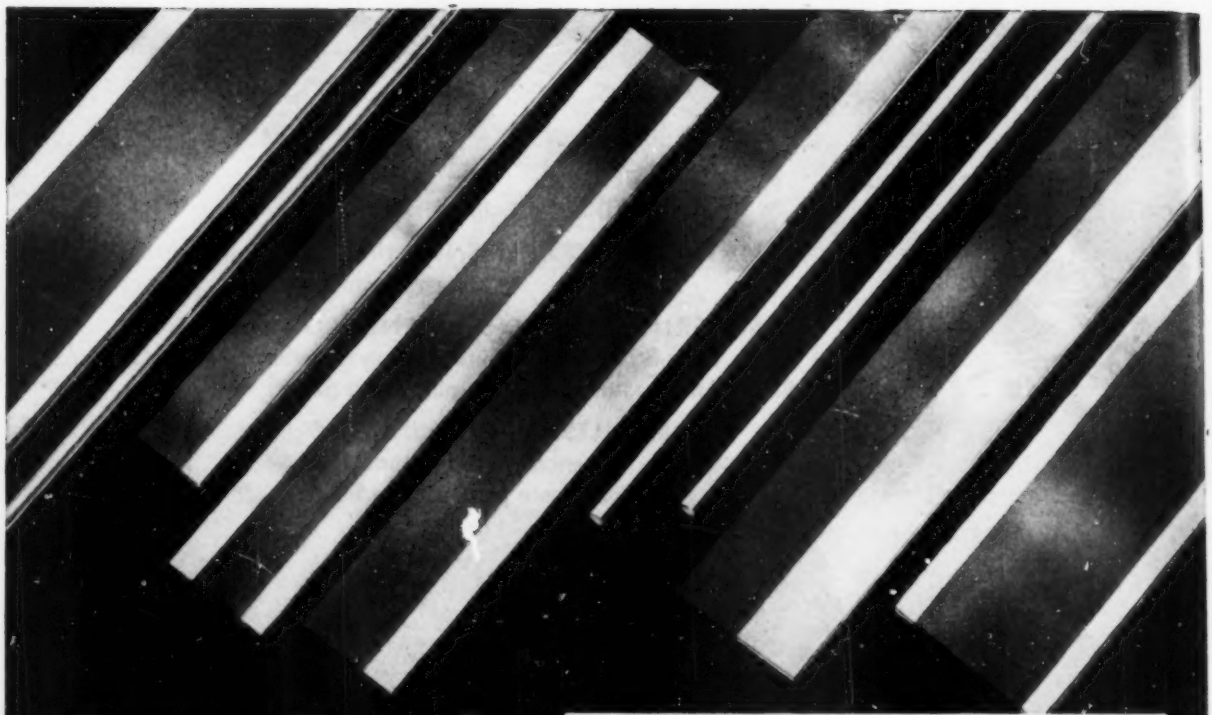

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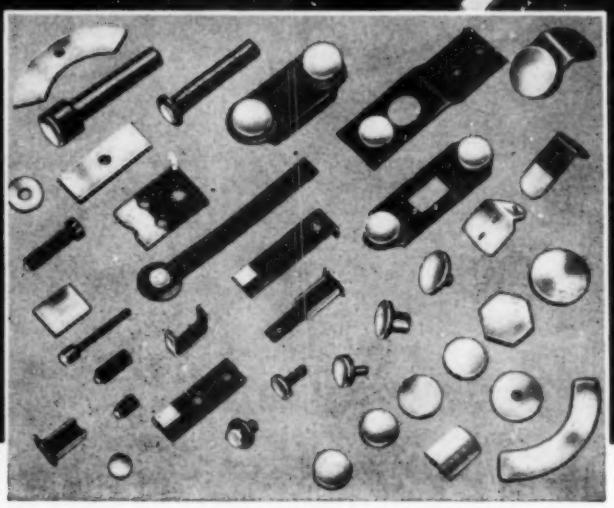

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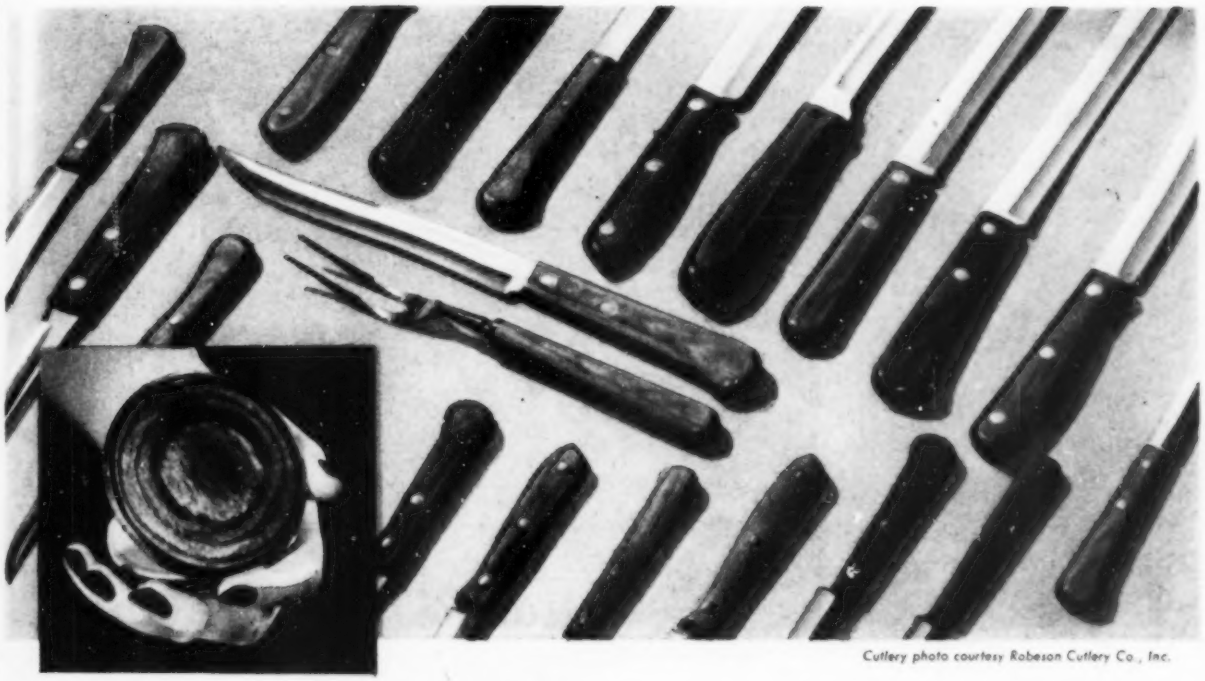

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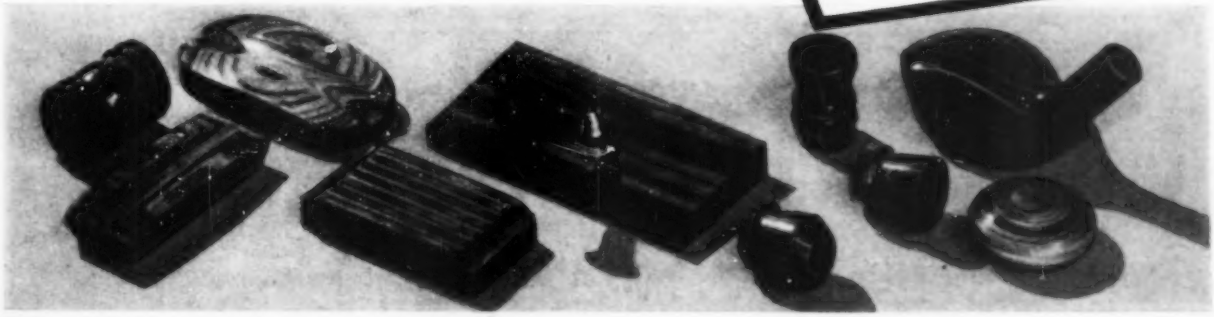

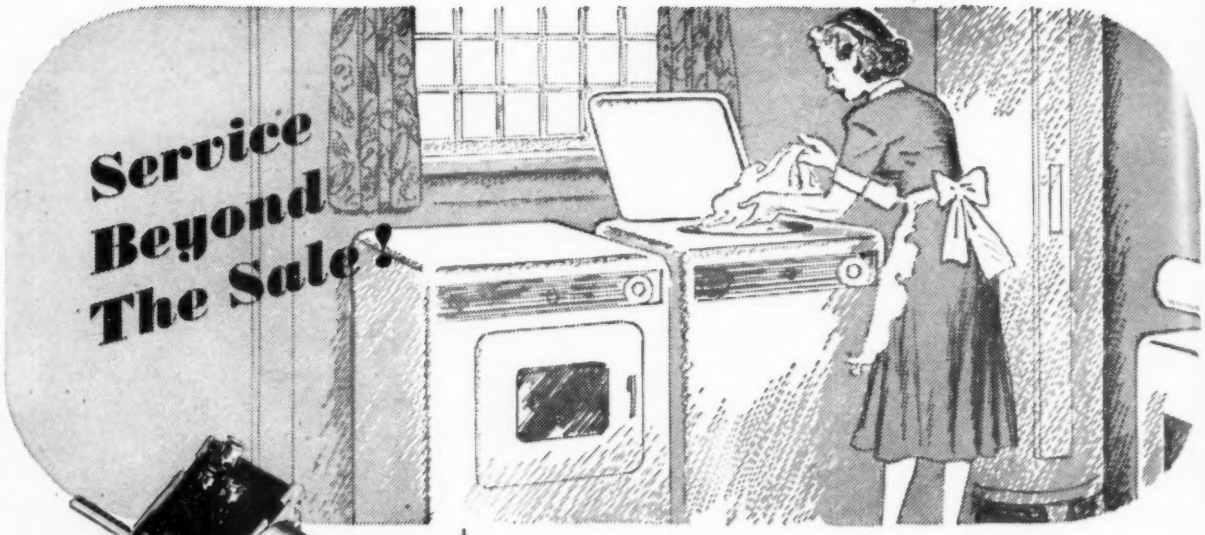

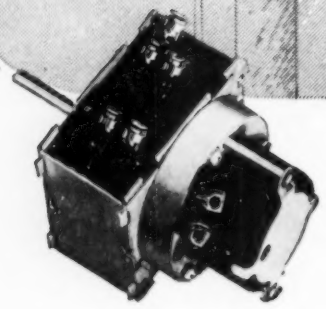

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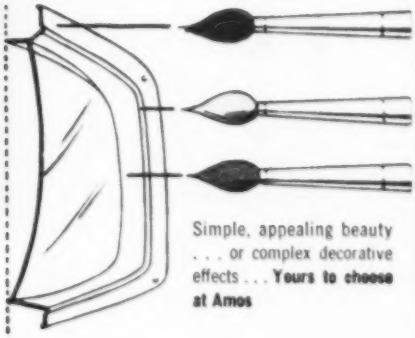
TV lens.



Simple, appealing beauty . . . or complex decorative effects . . . **Yours to choose at Amos**

Amos MOLDED PLASTICS

color finishing

Injection Molding Specialists—4 to 300-ounce Machine Capacity

Beautiful, sparkling, fadeless 3-color finishing *teams up* with ingenious design and molding perfection to produce:

Crosley's distinctive 17" wide-angle "family theatre" TV lens—with "proscenium arch" framing and slanted contour to reduce reflection.

(*A far cry from the* first *injection lens pioneered for the industry by Amos—a 7-incher in early 1948.*)

Amos' New **Larger** Equipment Molds **Bigger** Parts For Every Industry

Scores of customers in many industries *depend upon* AMOS *to do the complete job right*—DESIGN, ENGINEER, TOOL, MOLD and FINISH—all under one roof in one of the *most modern* plants in the industry. *Contact* AMOS . . . *Today!*

AMOS MOLDED PLASTICS · Edinburgh, Indiana
Offices: New York, Chicago, Detroit, Philadelphia

Here's a hunch from the Hospitals about Stainless Steel

ONE thing you're sure to notice, if you cast an observant eye around almost any hospital: the place shines with stainless steel equipment from basement to roof . . . in main and diet kitchens, ward kitchens, dressing stations, operating and delivery rooms—everywhere.

The reason for it is simply that hospital boards and managers are just as keenly alive to the individual needs of their business as any other good businessmen, and stainless steel does the job *best*. It maintains a hospital's rigid sanitation standards most perfectly, cleans easiest and quickest, and lasts longest in service—*because of all available metals*, stainless steel stands alone in its combination of great strength and high resistance to corrosion, heat and wear.

Put it down in your book that wherever it's used, Allegheny Metal is cheapest in the long run—and if that gives you a hunch for your own profit, let us help you to play it.

* * * * *

Complete technical and fabricating data—engineering help, too—are yours for the asking from Allegheny Ludlum Steel Corporation, Pittsburgh, Pa. . . . the nation's leading producer of stainless steel in all forms. Branch Offices are located in principal cities, coast to coast, and Warehouse Stocks of Allegheny Stainless Steel are carried by all Joseph T. Ryerson & Son, Inc. plants.

You can make it **BETTER** with

Allegheny Metal

W&D 3148

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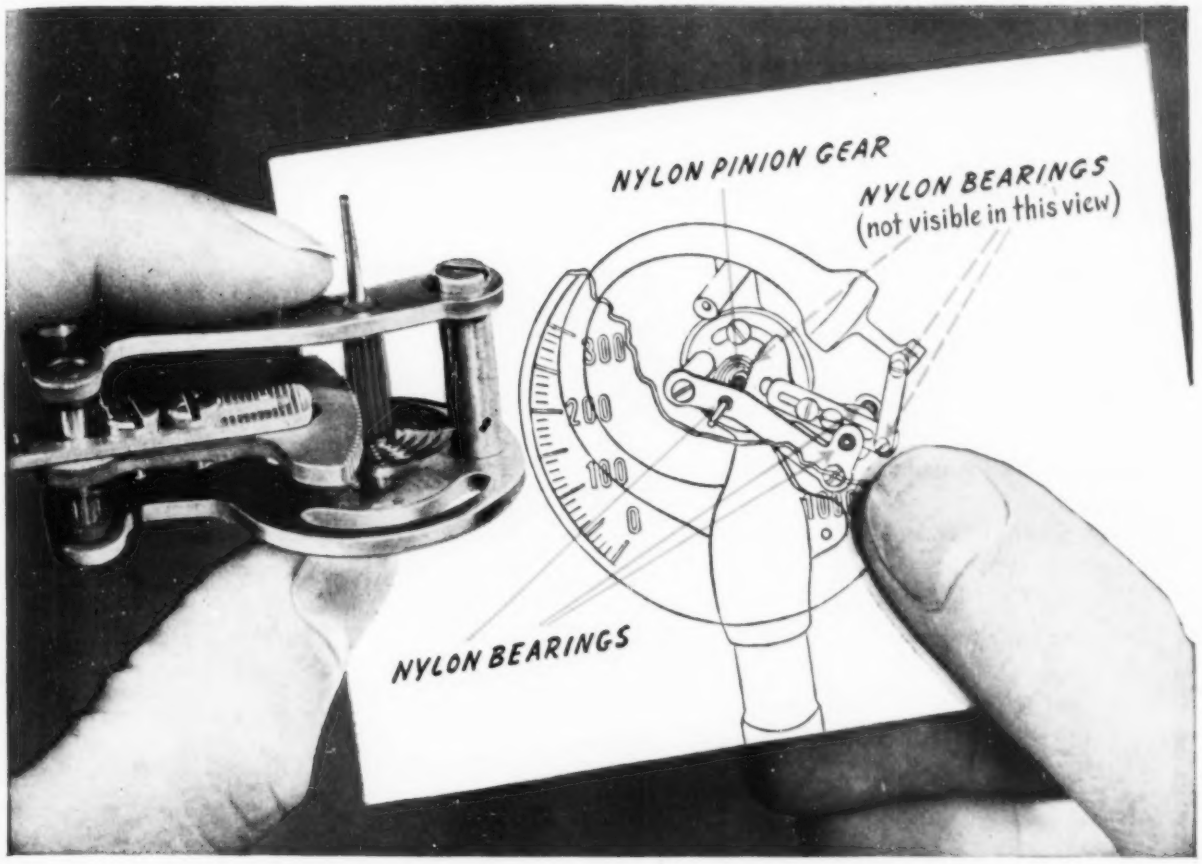
TIME-TESTED STAINLESS STEEL



NYLON PLASTIC GEARS AND BEARINGS

ABSORB SHOCK...RESIST WEAR...GIVE LONG LIFE

Severe vibrating and pulsating will wear down the mechanism of an ordinary pressure gauge . . . cause it to register inaccurately. To produce a gauge that would operate with utmost efficiency over extended periods, Manning, Maxwell and Moore developed a "nylon movement" for their Ashcroft "Duragauge." Five years of extensive field testing prove that the nylon movement outperforms and outlasts other gauge movements under severe conditions of vibration, pulsation and fretting corrosion.

NYLON PINION is machined from blank injection-molded directly onto metal shaft by Plastic Mfrs. Corp., Stamford, Conn. Nylon bearings are machined from rod stock supplied by the Polymer Corp., Reading, Pa. Accuracy of the gauge is guaranteed by its manufacturer to within one half of one per cent of dial graduation over entire scale of a full 270° dial arc.

Nylon parts offer an extremely low coefficient of friction. Too, nylon is highly resilient . . . resists abrasion. It absorbs vibrations without passing them along. Under shock loading, nylon's "plastic memory" allows parts to return to original size . . . maintains accuracy.

A large chemical company installed one of these gauges on "the worst pulsating service to be found." After 10 months of continuous use, the gauge was removed. Under microscopic examination, the nylon movement showed no visible wear!

Durable nylon plastic is finding more and more uses in gears, bearings, and machine parts for textile machinery, business machines, movie cameras, electric shavers, household appliances, and many other types of equipment. Its properties may well help you, too. For literature on nylon and other Du Pont plastics, write today:

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Polychemicals Dept., Sales Offices:
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E. 60th Street, Los Angeles 1, Calif.

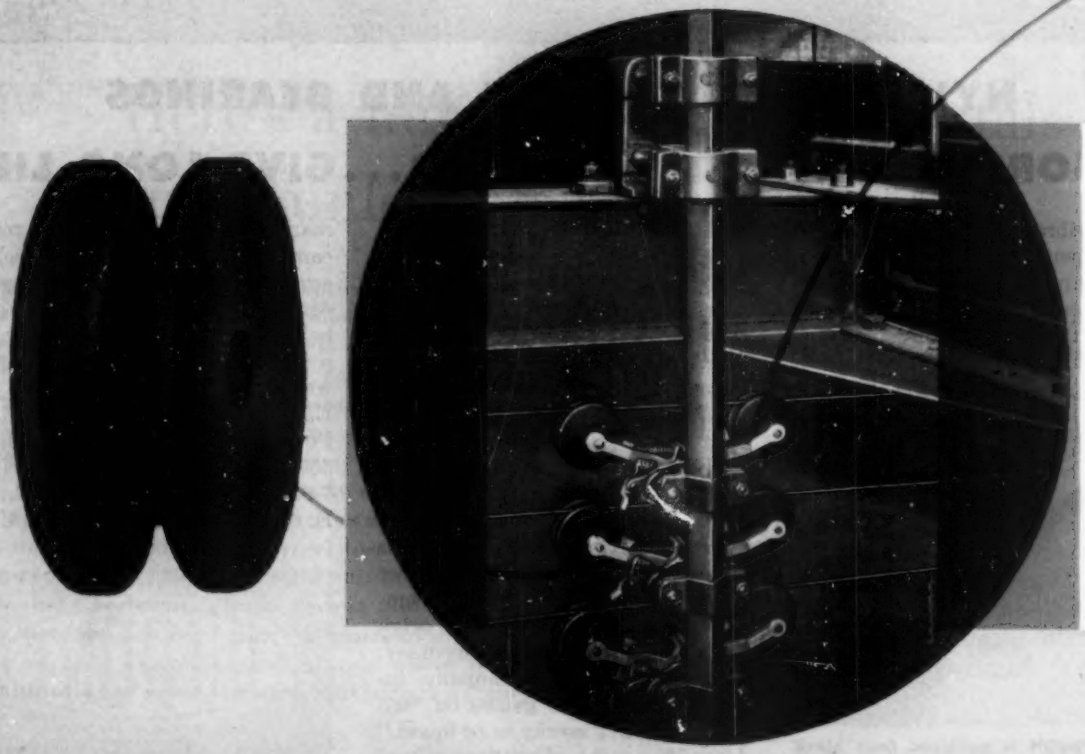
WHITING ELECTRIC TRAVELING CRANES

increase their efficiency

with GRAPHITAR

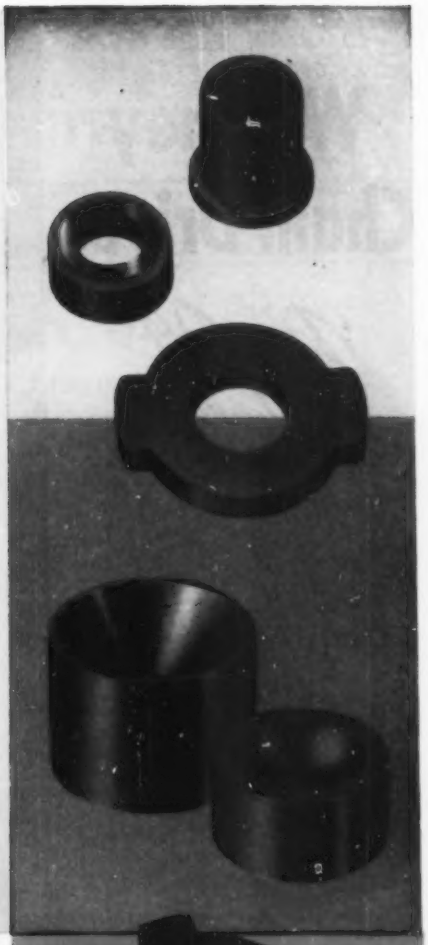
(CARBON-GRAPHITE)

There's more than one good reason why the Whiting Corporation of Harvey, Illinois uses Graphitar current-collector wheels on their overhead traveling electric cranes. They have found that Graphitar can be counted on to give long, trouble-free performance and increase the efficiency of the powerful Whiting cranes. Graphitar is a self-lubricating material, a fact that makes bushings unnecessary and banishes trolley wire greasing necessary with other collector-wheels. Graphitar has great wear resistance which means less collector-wheel replacements. Graphitar wheels virtually eliminate pitting, arcing and burning. Current-collector wheels are just one of many applications of Graphitar as an extremely useful industrial material.



THE UNITED STATES

CURRENT-COLLECTOR WHEELS



GRAPHITAR is finding its way into scores of new uses because of its many unique and valuable characteristics. Graphitar is chemically inert . . . practically unaffected by extreme temperatures and is self-lubricating under all conditions. It is extremely light yet mechanically strong. It can be molded into seals, bearings, bushings, rings and other parts . . . it can be ground to tolerances as close as .0005" in smaller sizes. It is available in many different grades to meet particular specifications and working conditions. Our engineers will be glad to study your sketches and perhaps suggest ways in which Graphitar can improve the efficiency of your operations. Ask for the new 64 page Graphitar catalog.

144

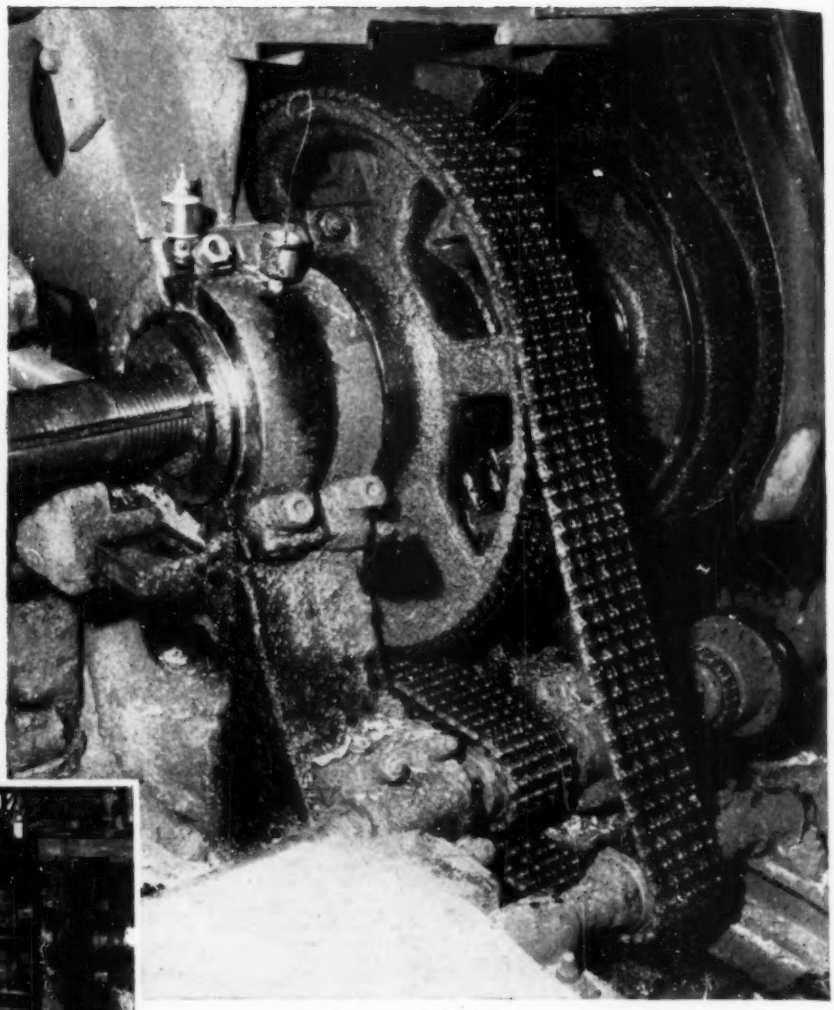
GRAPHITE COMPANY

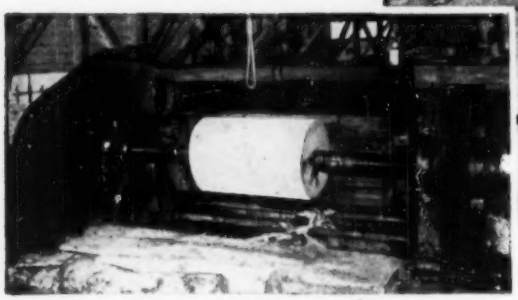
DIVISION OF THE WICKES CORPORATION, SAGINAW, MICHIGAN

Whitney Chain Drives

"Pay Off where the Chips Fly"

with Uninterrupted Service





Whitney Roller Chains transmit positive power on this 66-inch lathe.

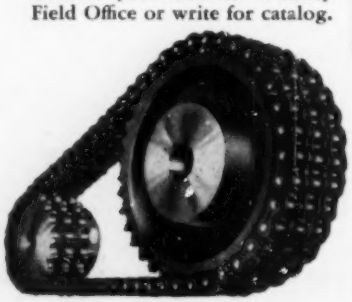
For over eighteen months, Whitney Chain Drives have been transmitting uninterrupted power on a 66-inch lathe in the Perry County Plywood Corporation at Beaumont, Mississippi. As the illustrations show, operating conditions are severe, and the chain has to operate constantly in wood chips and dust.

That Whitney Chain Drives stand up under the toughest of service is evidenced by the following quote from that company — *"We are extremely happy to report that from the moment the operation started, it has given us not a moment's trouble, nor have we as yet had to make any adjustments. Besides, the quietness of the machine with the chain drive would in itself have been well worth the change."*

Regardless of the type of equipment, whether it be for original installation or a replacement of the existing drive, Whitney Chain Drives . . . the all steel drives . . . meet the requirements for positive power transmission. Their versatility and adaptability enables them to meet standard or special requirements . . . permits operation on long or short centers . . . drive shafts clockwise or counter-clockwise from one power source simultaneously, while the hardened alloy steel construction throughout guarantees long life with minimum maintenance.

Whitney Service

And remember, Whitney Chain Drives . . . roller, silent, conveying chains, and cut-tooth sprockets . . . are carried in stock by more than 130 Whitney Distributors. This fast local service saves you time, assures prompt delivery. In addition 15 Whitney Field Offices, strategically located throughout the country, are at your service to help solve your power transmission problems. Consult your nearest Whitney Field Office or write for catalog.



Whitney Chain Company

204 Hamilton St., Hartford 2, Connecticut

EVER TRY STARTING WITH THE FINISH?

ONE of the interesting things about aluminum is that it can take every type of finish—from simple sand blasting to vitreous enamel, from conventional paints and lacquers to unique anodic coatings possible only with aluminum. And some of these finishes allow spectacular design flexibility. For example . . .

You might be designing a hydraulic system for aircraft. You want light weight cylinders and pistons. But you have greater need for wear resistance. With an anodic coating, you can give these aluminum pistons and cylinders a file-hard surface comparable to hard-chrome plating.

You may be concerned with the cost of a particular finish. Many finishes can be applied right at Alcoa's mills . . . saving you heavy investments in special equipment and manpower. These include Alzak* reflecting surfaces, Alumilite* finishes for gay, built-in color; special anodic coatings for greater corrosion resistance, or high dielectric strength; as well as a variety of decorative mechanical finishes.

An important thing to remember is that such finishes can be obtained on semi-fabricated parts made in Alcoa plants, to Alcoa quality standards, and available to you through a single, dependable source.

*Patented Process

Starting with the finish might prove an important way for you to reduce costs and improve quality. Any Alcoa sales office will be glad to consult with you about it.

ALCOA

FIRST IN ALUMINUM

In the following pages, Alcoa presents facts for sales designers on representative Alcoa products. On the last page of the Alcoa section will be found the Alcoa offices through which information on aluminum is available. ALUMINUM COMPANY OF AMERICA, Gulf Building, Pittsburgh 19, Pennsylvania.

THE ALCOA PRODUCTS ADVERTISED ON THESE PAGES ARE BACKED BY ALCOA'S RIGID QUALITY CONTROL...

ALCOA ALUMINUM SAVES ON SCREW MACHINE PARTS

Take a screw machine part you now make and figure what you can save by switching to Alcoa Aluminum Stock. You get three times as many parts per pound from aluminum.

Machining costs are the same as brass ... lower than steel. Aluminum requires no finish. But if you want a finish, aluminum takes and holds them all.

Once you see the savings on one part, you'll want to see more. All the information you need is contained in the free book, "Alcoa Aluminum in Automatic Screw Machines". Write ALUMINUM COMPANY OF AMERICA, 2117M Gulf Building, Pittsburgh 19, Pa.

ALCOA *Aluminum* SCREW MACHINE STOCK

ALCOA ALUMINUM

IN ADAPTING THEM TO YOUR USE, YOU ARE INVITED TO MAKE FULL USE OF ALCOA'S OUTSTANDING ENGINEERING HELP

ALUMINUM CLAMP AND SWIVEL BRACKET ASSEMBLY introduced on Mercury Outboard Motors in 1950, with phenomenal results... not one instance of breakage reported during entire boating season. Designed by Kiekhaefer Aeromarine Motors, Inc. Forged by Alcoa.

...for Aluminum Forgings
SEE ALCOA

Today's outboard motors are lighter, tougher, more powerful than ever before. Progress in outboarding, as in many other industries, has been achieved through the use of lighter, stronger materials . . . especially at the stress points.

If you are considering aluminum forgings as a way to design light weight and high strength into essential products, talk it over with our engineers. At Alcoa, forging experience teams up with improved facilities and new production techniques to give you quick, economical access to these valuable advantages . . .

- Light weight, combined with forged strength and compactness
- Tough, finely-knit grain structure
- Excellent, uniform physical properties
- Superior machinability
- Attractive appearance
- High resistance to corrosion
- Rapid heat transfer

Write for complete engineering information on Alcoa Forgings for your special application. Or just mail the coupon below. Our forging specialists are ready to work with you. If you would like to receive a copy of the new Alcoa Forgings Manual, please send request on your company letterhead.

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Aluminum Forgings by
ALCOA

ALUMINUM COMPANY OF AMERICA
1808M Gulf Building
Pittsburgh 19, Penna.

Please send me full information on aluminum forgings for the following application:

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Name _____ Position _____

Company _____

Address _____

City _____ State _____

THESE ALCOA SALES OFFICES *Will Aid You*

These sources of the Alcoa products (described on the preceding pages) are as near as your telephone. Let them serve you with engineering help, literature, and a pound or a ton of the Alcoa product that best meets your needs.

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Phone Tucker 5121
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Phone Yukon 6-6484

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Miami—1129 Alfred I. Du Pont Bldg.
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Phone Delaware 7-8181
Peoria—415 Commercial Natl. Bank Bldg.
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Fort Wayne—1935 Lincoln Tower
Phone Eastbrook 4676
Indianapolis—817 Merchants Bank Bldg.
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South Bend—805 J. M. S. Bldg.
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IOWA
Davenport—503 Kahl Bldg.
Phone 2-6243 and 2-6244

KANSAS
Wichita—411 Fourth Natl. Bank Bldg.
Phone 5-6624

KENTUCKY
Louisville—1154 Starks Bldg.
Phone Wabash 7456 and 7457

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New Orleans—627 Whitney Bank Bldg.
Phone Canal 3372

MARYLAND
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Phone Saratoga 8091 to 8094

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Boston—20 Providence St., Park Square
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Springfield—507 Tarbell—Watters Bldg.
Phone Springfield 3-5103

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Detroit—610 New Center Bldg.
Phone Trinity 1-8100
Grand Rapids—812 Michigan Natl. Bank Bldg., Phone Grand Rapids 9-0209
Jackson—1203 National Bank Bldg.
Phone Jackson 2-8206
Pontiac—301 Pontiac State Bank Bldg.
Phone Pontiac 4-1531

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Kansas City—2300 Power & Light Bldg.
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ALCOA FIRST IN ALUMINUM

ALCOA ALUMINUM ®

America's Road to Victory

. . . Let's Increase Production

This is the time to speak out—now—at the beginning.

Our industrial program for re-armament is getting off on the wrong foot.

The talking and writing about it emphasize the wrong things.

Its headline words are "cuts" and "controls."

Those words make bad propaganda for the cold war.

"Cuts" and "controls" are no words to challenge the imagination and energy of our own people. They won't impress the masters of the Kremlin. And they can only make it appear to the rest of the world that America thinks it can defend the free way of life by abandoning it.

America stands as the world's champion against aggression because America has become the most powerful free nation in the world.

How did we get that way?

Not by putting ceilings on wages; not by rationing or clamping iron-clad government controls all over business and industry.

To be sure, some temporary controls are necessary to channel very scarce materials speedily to use for defense. So, too, are special taxes and credit restrictions needed to combat inflation. But they will be fatal if they blind us to this fact:

We became the strongest nation in the world by out-producing every other nation.

Production—The Final Answer

Next year our government is planning at least a $40 billion military program. Instead of planning only on controls to divert $40 billion of production from the making of civilian goods to the making of military supplies, we should be figuring out also ways to push up total production.

Of course, our industrial plant is running at close to "capacity" now. And our labor force has reached almost full employment. There isn't much slack to be taken up.

Can even the United States add a $40 billion miracle of production on top of what it is already doing?

Our answer is "Yes"—and within two years. It can be done by adding about $6 billion each year to our program of capital investment which now runs about $22 billion a year.

Part of this added production will come from expanding our industries. The steel companies, for example, already have plans to increase their capacity almost ten per cent in the next two years.

But by far the largest part of that $40 billion of added production must come from higher productivity—raising industry's efficiency.

continued on next page

To meet our goals we need to raise our productivity five per cent a year.

Can it be done?

The answer is an emphatic "Yes."

Raise Industry's Productivity

McGraw-Hill's studies of industry's equipment show that there are countless opportunities for improving efficiency. Our manufacturing industries alone need at least $35 billion of new equipment to raise their facilities to first class technical standards.

Here are some of the broad possibilities reported by the trained editors of McGraw-Hill's business magazines:

In many manufacturing plants as much as 40 per cent of workers' time goes into moving materials and parts—shifting things about within the plant between processes and to and from shipping platforms.

FACTORY estimates that improved materials handling equipment and methods might well cut handling costs twenty-five per cent and save annually over 650,000 man-years of unnecessary labor.

Modern machine tools designed since World War II are 40 per cent more productive, on the average, than is old equipment. But AMERICAN MACHINIST surveys show that 95 per cent of industry's machine tools are of designs at least ten years old. Replacing them could raise productivity of the metalworking industries at least ten per cent—enough to absorb a major share of the metalworking industries' part of the defense program as now planned.

In coal mining, latest equipment and methods can raise productivity sharply. The editors of COAL AGE estimate that production of bituminous coal could be raised from seven tons per man-shift to ten within three to five years.

Many new textile production techniques are 50 per cent to 75 per cent more efficient than those in use now. If plants could be fully modernized, and full use made of latest management methods, TEXTILE WORLD estimates that output-per-manhour would rise 20 per cent. *A FOOD INDUSTRIES study indicates that modern equipment plus the best management techniques could raise productivity in food processing at least 20 per cent.*

These are just some of the opportunities that industry can seize and by which the nation can profit.

A Nation-Wide Effort

Of course, industry itself can't do the whole job. Labor, government and all the rest of us must cooperate.

Government's part is to see that its emergency controls are so applied that they will increase productivity and thus make possible an early lifting of such controls.

Labor's part is to help in the development of labor-saving methods and machinery and to welcome their adoption as the only sure way of continuing to advance the American standard of living while maintaining the American free way of life.

For all of us the job is to work constantly for an expanding, ever-stronger America with constantly growing productivity; not a pinched and shackled America cooped up under wage and price ceilings and tied to a ration card.

Challenge to Industry

Here is a sharp challenge to industry to study the best work-methods that are being reported—to use every minute and every dollar it can to replace obsolete equipment.

Here is a sharp challenge to government to do everything within its power to make its control policies and its fiscal policies strengthen the incentives to industrial modernization—to demand sacrifice for a purpose and not for effect.

The job to which such opportunities point will take time—though nothing holds back adoption of some of the simpler improvements in work-methods reported in business magazines all the time.

But increasing production is our one best hope that we may be spared the full array of price, wage and production controls now and be freed eventually from all controls.

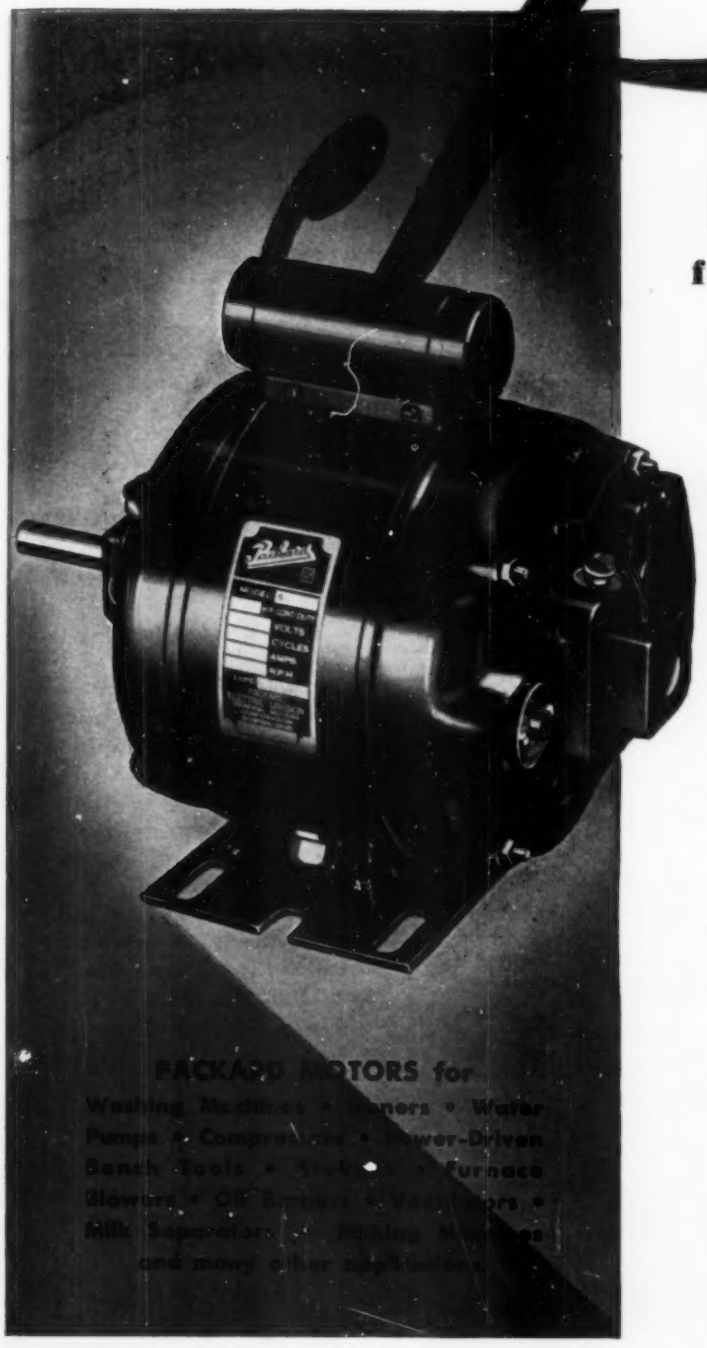
General Omar Bradley has said that the protection of our national independence calls for "long-range commitments that we are willing to carry out."

A long-range commitment to fight this battle for peace with America's most powerful weapon—industrial productivity—is the surest guarantee of victory for the free world.

Let's make that commitment—now—at the beginning.

McGraw-Hill Publishing Co., Inc.

Performance with a capital P



PACKARD
fractional horsepower
MOTORS

There is no question about the outstanding performance record of Packard fractional horsepower motors—their proved ability to create customer good will and increase the value and trade acceptance of your products.

Hundreds of thousands of Packard quality motors—all marked by rugged design, expert workmanship and finest materials—stand as evidence of this superiority.

Packard specializes in the manufacture of fractional horsepower motors. Our resources . . . our experienced engineering and manufacturing know-how in motor building have been concentrated for the past 34 years in this one field.

That's why Packard's reputation for plus-performance is described in capital letters —why it will pay you to specify Packard fractional horsepower motors . . . for quick service, complete satisfaction and lasting dependability.

GM GENERAL MOTORS

Packard

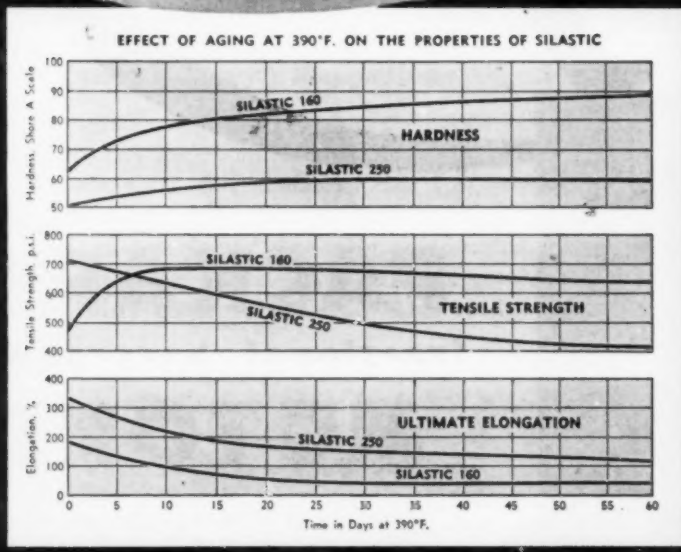
REG. U.S. PAT. OFF.

Packard Electric Division, General Motors Corporation
Warren, Ohio

DEPENDABLE APPLIANCE MOTORS FOR THIRTY-FOUR YEARS

Long after organic rubber melts or becomes brittle...

SILASTIC* still stays Elastic!



We're talking about an elastomer that retains its rubbery properties at temperatures far above and far below the limits of any other elastic material. That is indicated by the effects of accelerated aging at 350°F. on the properties of two typical Silastic stocks with brittle points in the range of −70° to −130°F.

Silastic is being widely used at temperatures in the range of 250° to 600°F. and at temperatures ranging from −75° to below −100°F. It shouldn't be called a rubber because that term invites comparisons that are not valid. At room temperatures, the physical properties and abrasion resistance of Silastic are well below the values normally associated with rubber. Conversely, at temperatures well within the serviceable limits of Silastic, rubber rapidly becomes a soft gum or a brittle solid.

The important thing about Silastic is that it retains its physical, chemical and dielectric properties over a temperature span of about 600 Fahrenheit degrees. When you need rubbery properties or good dielectric properties in a resilient and flexible material at temperatures beyond the limits of ordinary rubber, investigate Silastic.

*T. M. REG. U. S. PAT. OFF.

***SEND TODAY!** for your copy of Silastic Facts No. 10 containing new data on the properties, performances and applications for all Silastic stocks.*

from +500°F. **SILASTIC** stays Elastic to −100°F.

DOW CORNING CORPORATION, DEPT. R-24, MIDLAND, MICH.

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SILICONE NEWS

You can expect 200% to 300% LONGER LIFE with Silicone Base Paints

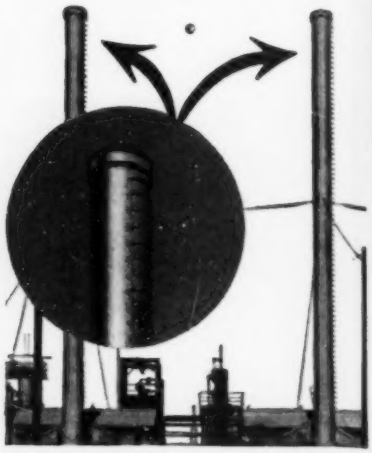

Photo courtesy The Dow Chemical Company Texas Division, Freeport

The two 50-foot powerhouse stacks shown above were coated in mid 1947 with a heat-resistant, modified silicone-aluminum paint formulated by the Kansas Paint and Color Company.

After more than 18 months exposure to high temperatures and corrosive atmospheres, the silicone-aluminum finish is still in excellent condition. Plant engineers are confident of at least another year of satisfactory service. Under similar conditions ordinary heat-resistant coatings broke down completely in six or nine months.

Here's proof that the durability of silicone-base finishes more than offsets their slightly higher initial cost. Actual increases of 200% to 300% in service life mean lower maintenance costs for your customers—greater sales appeal for your product. For more information write for pamphlet No. R-24-A.

DOW CORNING CORPORATION
MIDLAND, MICHIGAN

REMEMBER...
Dow Corning Silicones Mean Business

Give living a lift... with Steel!

Metal sculpture, executed in Weirzin steel, demonstrates the exceptional workability of this easily fabricated metal.

Plain or fancy, large or small . . . the living area *outside* a home can be planned to give a big bonus in pleasure.

And the outdoor furnishings needed to execute such plans are plentiful, durable and reasonable . . . because they're made of *steel*. Steel is America's great bargain metal for modern living

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NATIONAL STEEL CORPORATION

NEW CATALOGS AND BULLETINS

For copies of catalogs described here circle corresponding number on Reader Service card.

(44) BRAKES AND CLUTCHES—Warner Electric Brake Mfg. Co. Bulletin 703, 4 pp. A brake, a clutch, and a clutch-brake each in a number of sizes are electrically operated on direct current supplied by a power conversion unit. Cross sectional drawings and tables of dimensions for these units are included.

(45) HYDRAULIC CONTROLS—Blackhawk Mfg. Co. Condensed Catalog 2-B, 4 pp. Cutaway views and diagrams are used to illustrate pumps, rams, and valves which are designed to operate from 1,000 p.s.i. to 10,000 p.s.i.

(46) RUBBER DATA—Acushnet Process Co. Catalog 50, 32 pp. The first two sections describe the company's plant and products. The third section, Data, has been compiled to give readers a working knowledge of the properties and characteristics of various rubber compounds. This section includes methods of molding, case histories on development of compounds for special applications, and a description of natural and synthetic rubbers.

(47) HARD METAL CASTING—Stoody Co. Booklet, 16 pp. This company manufactures hard metal alloy castings such as those of cobalt-chromium-tungsten by a centrifugal process which involves casting at a very high pressure with a rapid quench. The booklet describes the advantages in using this type of casting and the limitations as far as size is concerned. The firm's products are fully illustrated.

(48) RUST PREVENTIVES—Dearborn Chemical Co. Folder, 8 pp. Describes chemically inhibited coatings which are designed to prevent metal loss under corrosive conditions. First, the method of selection is outlined. Second, recommendations are made according to the degree of protection required. Third, the cleaning of metal surfaces prior to coating is described.

(49) CONTROL MOTORS—Transicoil Corp. Chart, 8 pp. Contains tabulated data on physical dimensions and electrical characteristics of twenty-five miniature control motors. Other information includes the types of housings, bearings, finishes, and similar physical characteristics of these motors.

(50) SOLDERING TIPS—Weller Electric Corp. Booklet, 20 pp. Presents a series of 15 illustrated rules to improve soldering techniques. Following these are some instructions for the care of a soldering gun along with information concerning the manufacturers products.

(51) INSULATION TESTING METERS—Associated Research Inc., Bulletin 2-A, 4 pp. Lists a group of 29 instruments for testing the electrical charateristics of insulating materials. Given are illustrations of a number of the models as well as the physical dimensions and electrical capacities of all of the models.

(52) MANGANESE STEEL CHAIN—Taylor-Wharton Iron and Steel Co. Bulletin 150, 4 pp. Points out the long wearing characteristics of chains made of manganese steel. Shown in illustrations are the construction details of this firm's chains and some of their applications.

(53) ADHESIVES, COATINGS AND SEALERS—Minnesota Mining & Manufacturing Co. Booklet, 32 pp. Offers tables of properties of adhesives, coatings and sealers. The properties of the product are presented from the standpoint of their use, the methods of applying them and their applications. The adhesives are for bonding metal, rubber, glass, plastics, fabrics and wood. The coatings are for protecting metal against corrosion and abrasion, for thermal protection of motor housings, and for sound deadening of metal panels. The sealers are used in manufacturing auto bodies, refrigerators and other products.

(54) HARDFACING ALLOYS—Air Reduction Co., Inc., Catalog 11, 20 pp. Divides the hard facing alloys produced by this manufacturer into three groups, ferrous alloys, non-ferrous alloys with a cobalt base, and tungsten carbide alloys. Each alloy is then described, its application and typical uses are outlined and the procedure for depositing it on a surface is given. Dimensional data, a hardness conversion table, grinding wheel specifications, and a pre-heating chart are included.

(55) INVESTMENT CASTINGS—Hitchiner Mfg. Co., Inc., Bulletin, 5 pp. Indicates the possibilities and limitations of investment castings. Included are a number of illustrations of parts than can be formed by investment casting for a variety of fields.

(56) AGE-RESISTOR FOR RUBBER—American Cyanamid Co. Technical Bulletin 815-A, 24pp. After discussing the physical and chemical characteristics of this antioxidant, the bulletin goes on to describe a series of tests, each of which is displayed in tabular form or by graph, comparing the effect on rubber of adding various amounts of this product. Among these are tensile tests, tensional creep tests, light exposure tests, and a number of others.

(57) LABORATORY APPARATUS AND SUPPLIES—Burrell Corp. Catalog 450, 986 pp. Lists and describes 25,000 items of labortary apparatus and supply. Its principal feature is a cross index system whereby items are listed by name and again, separately, by function.

(58) HYDRAULICS—Sun Oil Co. Technical Bulletin B-4, 44 pp. Contains a treatment of the principles of hydraulics and the components of hydraulic systems. All the types of each of the four major components, the oil reservoir, the pump, the valves and the hydraulic motor, are explained, and their functions are diagrammatically shown. Selection of oil for the hydraulic system is the concluding topic. In this section, the properties of oil are examined and the types of oil available are listed.

(59) MOTOR STARTERS—Allis-Chalmers Manufacturing Co. Bulletin 14B3410A, 12 pp. Built for 2,300 to 5,000 v squirrel cage wound rotor and synchronous motors, this line of motor starters is described with the aid of diagrams and illustrations. Used in this motor starter is the company's air break contractor which is more fully presented in a separate folder, Bulletin 14B7303, that is also available.

(60) SILVER ALLOY BRAZING—Handy and Harman. Bulletin 20, 24 pp. After discussing the firm's products, two silver brazing alloys, one of which is used for joining ferrous and non-ferrous materials and the other for joining non-ferrous materials only, the booklet continues with a pre-

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sentation of the problems involved in designing joints for brazing, the steps to follow in brazing, the heating mediums that may be employed, and the method of finishing the part after brazing is completed.

(61) FLEXIBLE HOSE AND FITTINGS—Aeroquip Corp. Bulletin 113, 6 pp. Illustrates and briefly describes flexible hose and its fittings and lists in tabular form the sizes and other characteristics of each product. Included also is some descriptive matter on the company's couplings.

(62) WELDED STEEL TUBING—Brainard Steel Co. Bulletin, 8 pp. Shows the manufacture of welded steel tubing by means of a diagrammatic sketch. Continuing with an outline of the advantages both from a structural and a fabricating point of view, the bulletin goes on to point out applications in which these advantages may be secured. Tables showing weight per linear foot and size and gage tolerances conclude the discussion.

(63) WELDMENTS—Graver Tank & Mfg. Co., Inc. Booklet, 20 pp. Contains many illustrations of structures fabricated by welding. Examples are gear blanks, tanks, furnaces, locomotive hood superstructures, and gear cases. A running commentary brings out the advantages of using weldments and the services that are available in this company.

(64) MOLDED RUBBER PARTS—Allis Rubber Corp. Booklet, 32 pp. Begins with a brief description of each of the more common synthetic rubbers and then goes on to explain how they are compounded with other materials to produce a substance with the desired properties. The fabrication techniques such as extruding, molding, inspection and trimming are the next subjects, and they are followed by a series of examples of parts made from the various synthetic rubber compounds. Included is a chart comparing the properties of natural rubber and the various synthetic compounds.

(65) TAPE—Bauer & Black, Div. of the Kendall Co. Booklet, 10 pp. Lists the twenty-four tapes manufactured by this firm. Each is illustrated, and accompanying each is data concerning its backing, thickness, adhesion qualities, tensile strength, dielectric strength, insulation resistance and corrosion resistance. Suggested applications are shown.

(66) THERMOMETERS — Electric Auto-Lite Co. Bulletin, 4 pp. Contains information concerning a group of dial indicating and recording thermometers. Each comes in a number of models which are illustrated. Available also is a bulletin which con-

erns itself with the features and operation of the recording thermometer only. A third bulletin describes the company's recording pressure gage.

(67) ELECTRICAL CONTROLS AND RESISTORS—Clarestat Mfg. Co. Catalog 50, 20 pp. Outlines the firm's line of products which include controls, resistors, rheostats, voltage regulators, TV beam benders and constant impedance output attenuators. Each product is described briefly, and for each is given the models in which it is available.

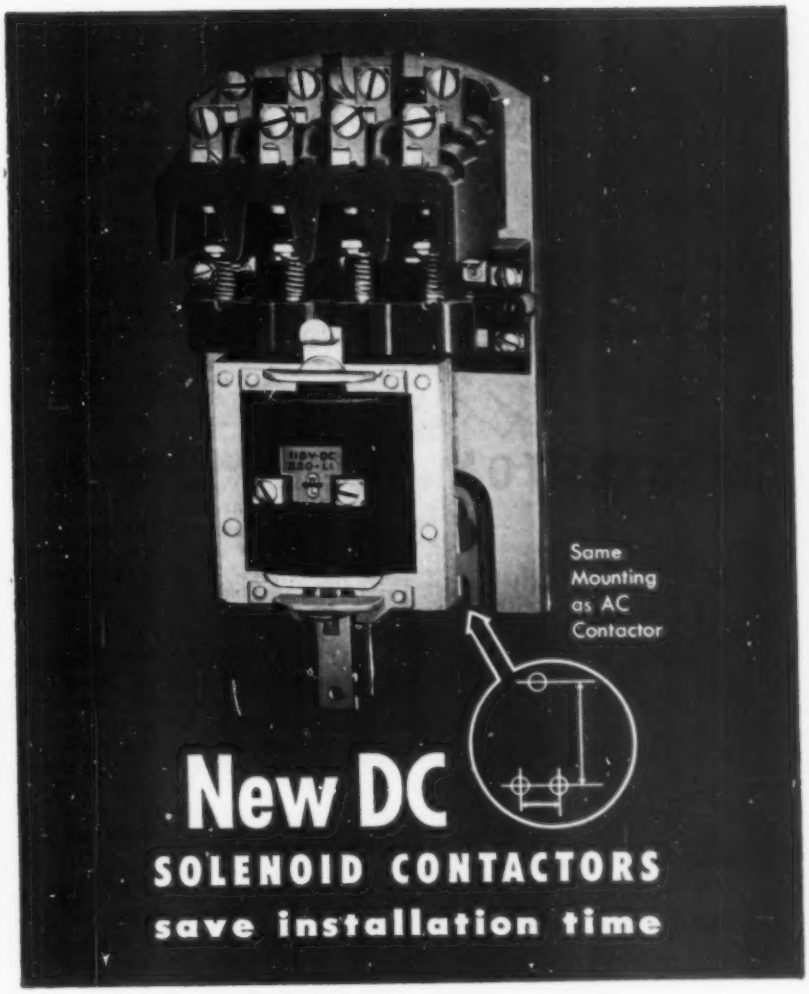
(68) HEAT MEASURING DEVICES—Wheelco Instruments Co. Bulletin TC-8, 38 pp. Proper selection of a heat measuring device depends on the temperature range that is to be measured, whether duty is continuous or intermittent, the atmospheric conditions that are present, and the location of the heat source to be measured. Shown are a line of thermocouples, radiation detectors, resistance bulbs and their accessories, each of which is designed to suit a given set of these conditions. Information on how to make a thermocouple, how to check thermocouples and pyrometers as well as tabulated data and charts relating temperature to voltage for the various thermocouple materials is offered.

(69) GASKETING — Products Research Co. Bulletin, 4 pp. Described is the company's adhesive back, impregnated felt gasketing. Sizes and properties are discussed, and some illustrations of its application are presented.

(70) CORROSION-RESISTANT PLASTICS—Munray products, Inc. Folder, 8 pp. Offers a group of plastic products such as coatings, piping and tubing, and linings which are designed to resist corrosion. In addition to illustrative matter displaying the products and their application, there are tabulated data concerning their properties and corrosion test results.

(71) STAINLESS STEELS—Crucible Steel Company of America. Booklet, 32 pp. Examines the equipment problems in each phase of the textile industry and points out wherein the types of stainless steel may answer them. The booklet is replete with illustrations and diagrams and includes charts comparing the types of stainless steel as to chemical composition, strength, cost, and other factors.

(72) SPEED REDUCERS — Falk Corp. Engineering Bulletin 3110, 16 pp. Provides selection information, dimensions, rating tables, and service factors for a line of right angle speed reducers complete with motors. Three models are available. The first mounts a foot type motor on a bracket carried by the speed reducer frame. In the



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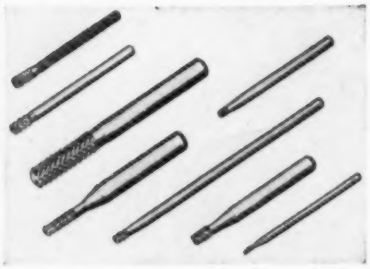

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We are also set up to make for you such parts as special rollers, studs, dowel pins, screw driver and ice pick blades, surgical and dental instruments, pen and pencil barrels, instrument shafts and pivots, special needles, etc.

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second, a flange type motor mounts directly on the speed reducer housing. In the third, both the motor and the speed reducer mount on a separate base. Speeds range up to 1,750 rpm and power output up to 50 hp.

(73) MATERIALS SELECTION CHART—Cooper Alloy Foundry Co. Folder, 4 pp. Lists a number of corrosives and indicates which of a series of steels and other alloys will give satisfactory service when used with them. The metals appear in order of increasing cost for a given chemical so that the economical satisfactory metal can be picked out easily.

(74) COLD PRESSURE WELDING—Koldweld Corp. Folder, 4 pp. Using as examples a number of problems submitted to this manufacturer for solution, this folder shows how the process of cold pressure welding can economically replace other assembly methods.

(75) TEFLON PACKINGS—Garlock Packing Co. Bulletin, 8 pp. Describes a line of packings and gasketing materials made of Teflon which are inert to chemicals, are heat resistant and can be used in a temperature range from −90 F to +500 F. The packings are available in braided or molded types, and the gaskets come in solid or envelope forms.

(76) MOISTURE REMOVAL—Jas. A. Murphy & Co. Booklet, 28 pp. Cutaway views and diagrams are used to explain the functioning and the features of a group of products designed to remove moisture and other matter from compressed air. The products include a moisture separator, strainer, moisture trap, aftercooler, and a combination aftercooler, separator and filter. Each comes in a number of designs.

(77) PLASTIC MOLD CASTINGS—Ohio Precision Castings, Inc. Booklet, 18 pp. This firm supplies castings produced from plaster molds made of such materials as brass, bronze, aluminum, and beryllium copper alloys. The booklet is made up of displays of parts made by this process for a number of its customers.

(78) ANTI-CORROSION COATING—Industrial Metal Protectives, Inc. Bulletin, 8 pp. Presents case histories of typical applications of the company's corrosion and abrasion resistant coating as well as specifications for the two formulations of the coating and data on surface preparation and methods of application.

(79) NEOPRENE BELTING—Baldwin Belting, Inc. Catalog 2 pp. Describes a neoprene belting designed for light conveying and transmission work. A table of specifications is included and applications are indicated.

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1

Slip a HEYCO Nylon Strain Relief Bushing on wire. *(Heycos eliminate cord wear at chassis entrance.)*

2

Snap HEYCO into chassis hole. *(The Heyco imparts a positive non-slip grip; does not injure wire.)*

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1. Save time—reduce costs
2. Absorb cord pull, push and torque
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5. Eliminate tying knots
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You will find HEYCOS being used on an increasing number of nationally known appliances . . . toasters, heaters, clocks, roasters, mixers, record players, radios, television sets, toys, lamps, polishing machines, etc.

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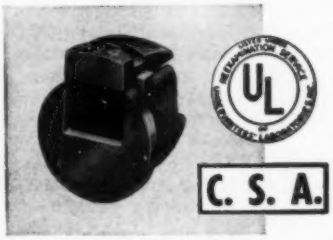
for clock wire to S-10/3 cable



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The world's most accurate (and rugged) time measuring instrument. Available in 8 models as shown below:

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SM-60	1/100 min.	60 min.	± .002 min.
S-10	1/10 sec.	1000 sec.	± .02 sec.
S-6	1/1000 min.	10 min.	± .0002 min.
S-1	1/100 sec.	60 sec.	± .01 sec.
MST	1/1000 sec.	.360 sec.	± .001 sec.
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Manually and Electrically Operated Portable Cases or Panel Mounting optional changes to conform to customers' requirements.

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MEETINGS

December 26-31

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE—Annual Meeting, Public Auditorium and Downtown Hotels, Cleveland, Ohio.

December 29

SCIENTIFIC RESEARCH SOCIETY OF AMERICA—Annual Convention, Allerton Hotel, Cleveland, Ohio.

January 8-12

SOCIETY OF AUTOMOTIVE ENGINEERS—Annual Meeting and Engineering Display, Book-Cadillac Hotel, Detroit, Mich.

January 10-12

SECOND HIGH FREQUENCY MEASUREMENTS CONFERENCE sponsored jointly by the American Institute of Electrical Engineers, the Institute of Radio Engineers and the National Bureau of Standards—Hotel Statler, Washington, D. C.

January 18-20

SOCIETY OF PLASTIC ENGINEERS—Annual National Technical Conference, Hotel Statler, New York City.

January 19

MALLEABLE FOUNDERS' SOCIETY—Semi-Annual Meeting, Hotel Cleveland, Clevelan , Ohio.

January 22-26

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS—Tenth Heat and Ventilating Exposition, Bellevue-Statford Hotel, Philadelphia, Pa.

January 29-February 1

INSTITUTE OF AERONAUTICAL SCIENCES –Nineteenth Annual Meeting, Hotel Astor, New York City.

February 18-22

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS—Annual Meeting, Jefferson Hotel, St. Louis, Mo.

March 5-9

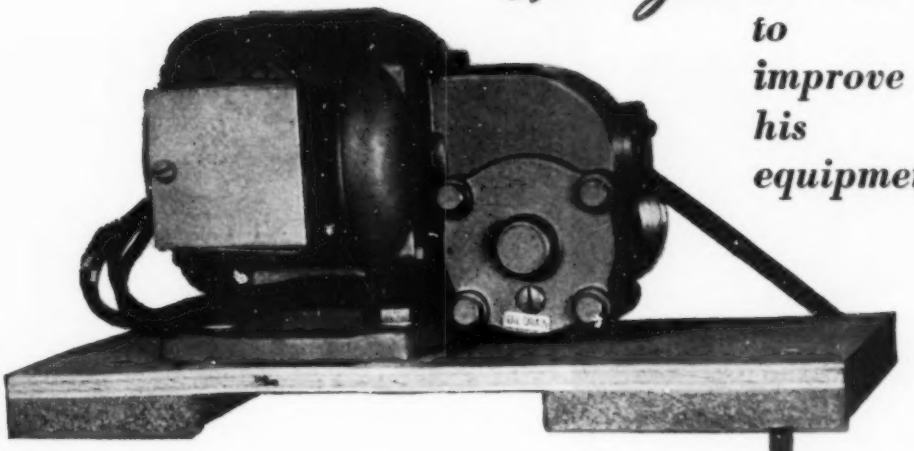
AMERICAN SOCIETY FOR TESTING MATERIALS—Spring Meeting and Committee Work, Netherlands-Plaza Hotel, Cleveland, Ohio.

March 19-23

SEVENTH WESTERN METAL CONGRESS AND WESTERN METAL EXPOSITION under the management of the American Society for Metals—Oakland Auditorium, Oakland, Calif.

an imaginative photographer uses

Spongex® cellular rubber *to improve his equipment*



Portable motor no longer "walks" away from its job

Jack Stock's portable motor "walked" away every time he put it to work. He mounted the motor on Spongex cellular rubber—now it stays on the job. Spongex absorbs the vibrations that give legs to portable motors.

Mr. Stock is in the commercial photography business; he doesn't manufacture motors. As a neighboring businessman in Shelton, he is well acquainted with the properties of Spongex cellular rubber. Now he mounts all his motors, stationary and portable, on Spongex.

Smaller illustrations show other ways Spongex helps to produce better results in Mr. Stock's business.

If you have a vibration, insulation, cushioning, gasketing, sealing or sound damping problem, think about *Spongex*. Cellular rubber does not become a "product" until you make it one in *your* application.

Technical Bulletin on Sponge Rubber available on request.

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Uniform, dustless, printing contact
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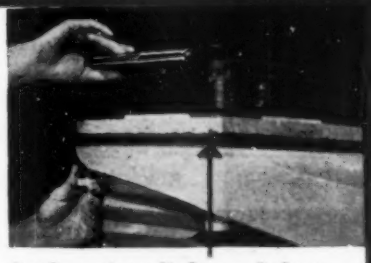

Seal against light and dust
In installing this copy camera attachment, custom made by Mr. Stock, on top of a photograph enlarger it was essential to block out dust and light. A Spongex gasket performs perfectly

Resilient compression pad
This dry mounting press is fitted with a resilient Spongex cellular rubber base. Spongex equalizes pressure to mount photographs evenly and more securely on their backing

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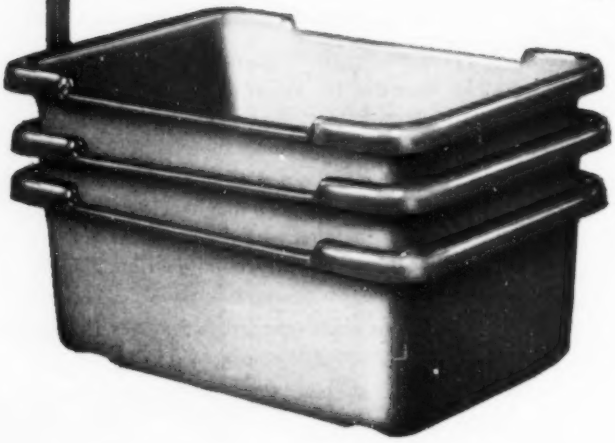

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Add to these, the other famous Royalite advantages, and you will see why our new design is widely acclaimed by both employees and management.

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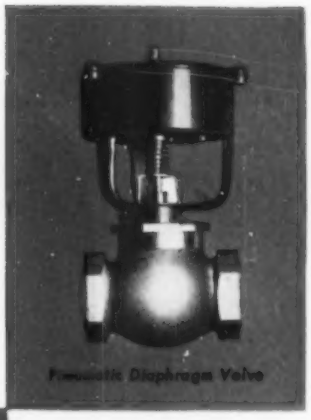
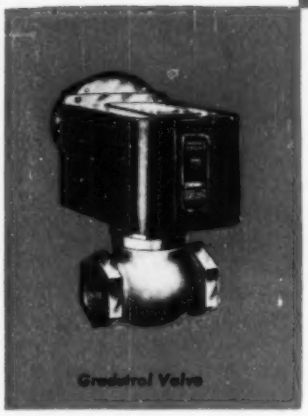
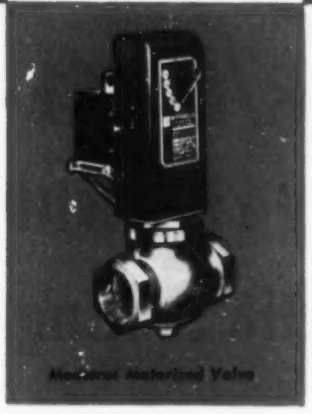
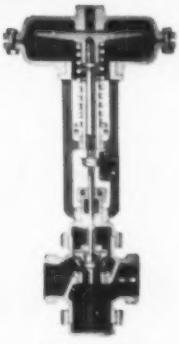

Pneumatic Diaphragm Valve


Graduirol Valve

Slip Stem Globe Type Motorized Valve


Mechanical Motorized Valve


Low-lift Valve

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You'll find the right control valve for your product in the Honeywell Line—whether it must be pneumatically or electrically operated. There's a wide variety of types and sizes—for pressures as low as a few inches of water up to 1200 psi. Their extreme ruggedness and dependability have met the test of service in thousands of systems throughout industry. Low in cost, easy to install and requiring little or no maintenance . . . they return big dividends in years of uninterrupted, trouble-free operation.

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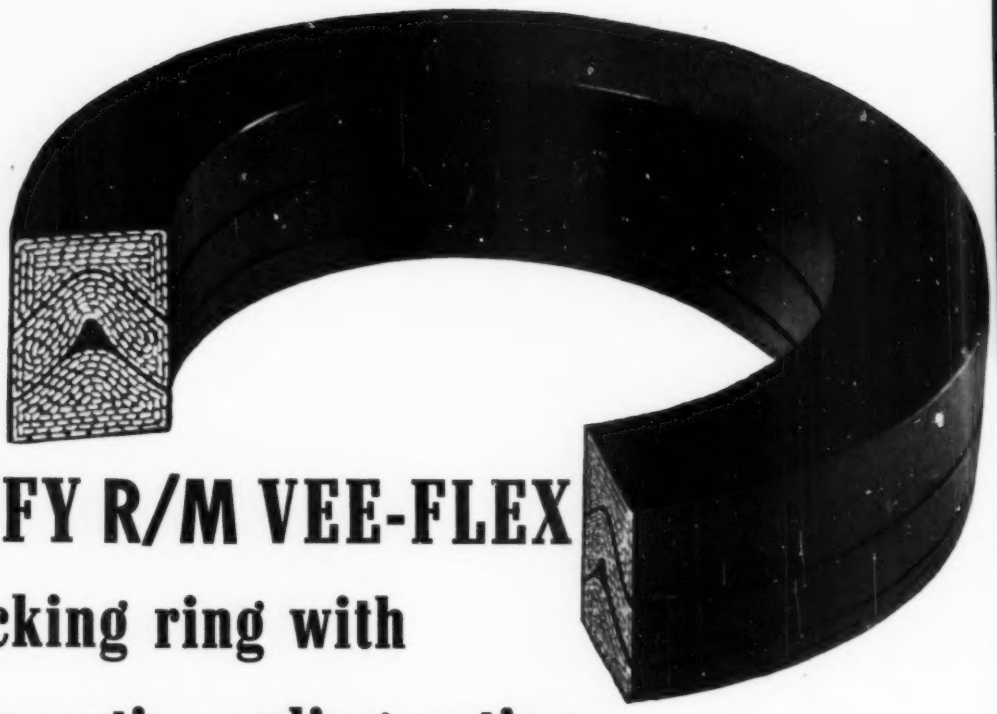

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the packing ring with the automatic sealing action

R/M Vee-Flex Packing Rings have been used for years to insure efficient sealing in valves, pumps, hydraulic cylinders, rams, pistons, lifts, accumulators, shock absorbers, and other equipment.

They are available in sizes for all applications in modern machinery. Special materials are provided for use in contact with oil or food handling equipment.

The rings are designed so that fluid pressure automatically spreads the lips and thus increases the efficiency of the seal against rod or stuffing box wall. When pressure is released, the rings contract, thus decreasing friction and making possible longer service.

R/M Vee-Flex Rings nest together in sets, providing a multiple seal in limited space. "Finger-tight" adjustment is all that is necessary to insure sealing. Fill out the coupon below for complete information on Vee-Flex Rings.

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PACKING DIVISION, MANHEIM, PA.

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R/M

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NEW PHOTOGRAPHIC MATERIALS...
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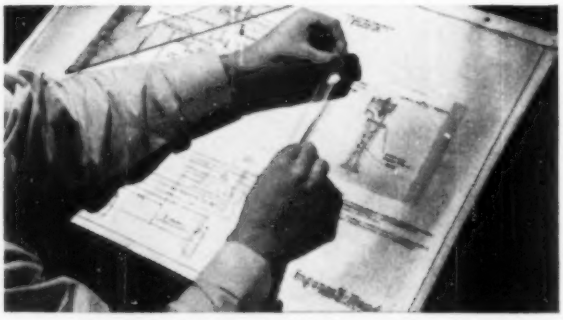
"Ink quality" file copies of pencil drawings are produced with Kodagraph Autopositive Cloth

Instead of making expensive "ink on cloth" tracings of its original drawings, Ingersoll-Rand simply reproduces them on Kodagraph Autopositive Cloth. This new photographic material produces positive copies *directly* (like Kodagraph Autopositive Paper and Film) . . . without the negative step . . . without darkroom handling. No special equipment is required, either: a photocopy machine is used for the exposure operation . . . standard photographic solutions for development. *Result:* intermediates that have the sharpness, the sparkle of new ink tracings . . . with non-smudging, dense photographic black lines on a durable white cloth base.

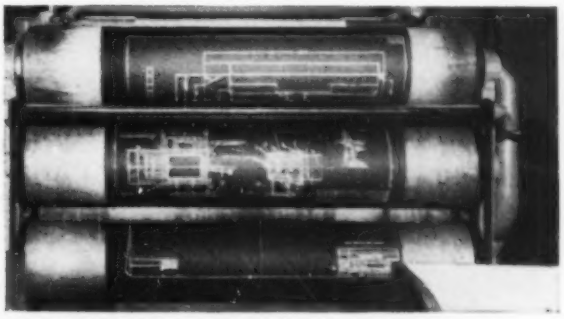
Old, soiled, or damaged drawings are restored with Kodagraph Autopositive Paper

When such drawings are taken from the files, the call is for Kodagraph Autopositive Paper—to eliminate hours of expensive retracing time. This low-cost, high-contrast photographic material increases line density . . . cleans up backgrounds . . . in many cases delivers serviceable intermediates that require no handwork at all. Drawings in very poor condition are restored by Ingersoll-Rand in the following manner: after an "Autopositive" is made, stains, creases, and other unwanted elements are removed with eradicator fluid or razor blade. Then, the print is used to produce a second "Autopositive," which is touched up with pencil if necessary.



Standard units are added to new drawings with Kodagraph Autopositive Film

Among the many ingenious drafting short cuts developed by Ingersoll-Rand is the use of Kodagraph Autopositive Film overlays made from standard-component drawings. These transparencies are kept on file . . . and taped to new drawings whenever necessary. Following this, the composite is reproduced on Autopositive Paper. *Result:* a photographic intermediate of uniform line density . . . plus important savings in drafting time.



Additional advantages of using Kodagraph Autopositive intermediates

Sharper, cleaner blueprints are produced—at uniform, practical speeds—because Ingersoll-Rand makes them from "Autopositives" instead of its perishable original drawings. This way—there's far less chance of "reading errors" in the shop. And valuable originals are protected against machine wear and tear . . . constant handling; are kept safe in the files available for reference and revisions only.

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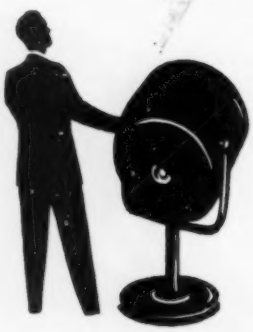

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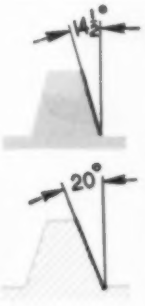
Important Notice to all readers of Product Engineering

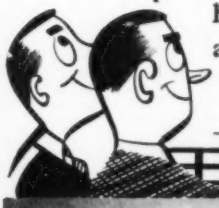
BOSTON GEARS cut 20° Pressure Angle

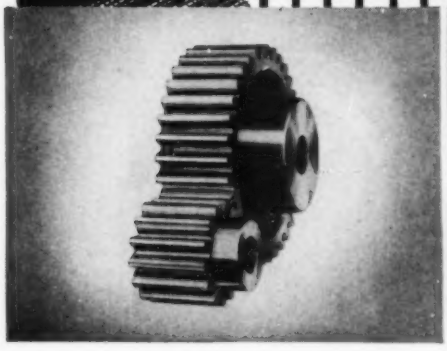
Quieter — Longer Life

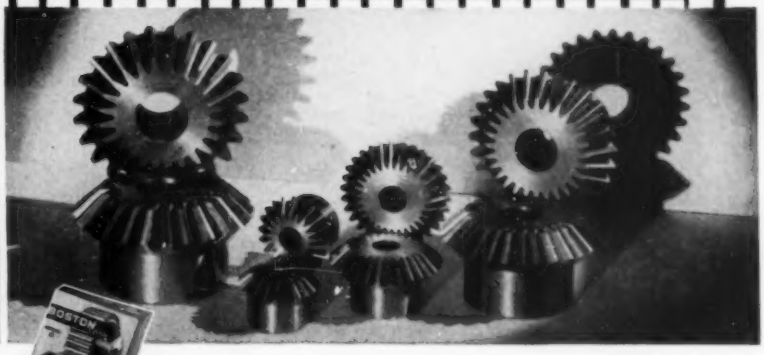
- TRANSMIT MORE HORSEPOWER
- RUN QUIETER
- LAST LONGER



ASK THE NEAREST BOSTON GEAR DISTRIBUTOR to show you a pair of Boston Gears cut *20° Pressure Angle.* See for yourself why they are stronger and will take loads otherwise requiring heavier pitch, larger pitch diameter, more expensive, 14½° angle gears. Design them into your equipment.







BOSTON SPUR GEARS cut 20° Pressure Angle are *stocked* in 12 – 10 – 8 – 6 and 5 pitch sizes. Consult your new Boston Gear Catalog No. 55.

FOR COMPLETE INFORMATION on Boston Gears write for free copy of Boston Gear Catalog No. 55.

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BOSTON Gear stocks are Near

BOSTON GEAR WORKS

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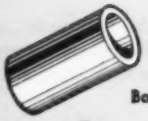
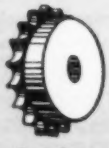
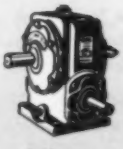
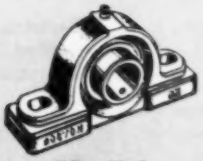
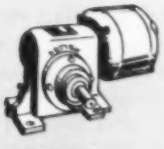

Bost-Bronz Bearings

Universal Joints


Sprockets


Reductors


Pillow Blocks


Ratiomotors

Bearings

Couplings

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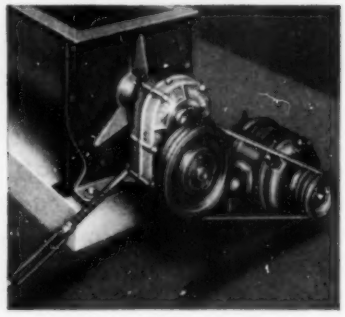

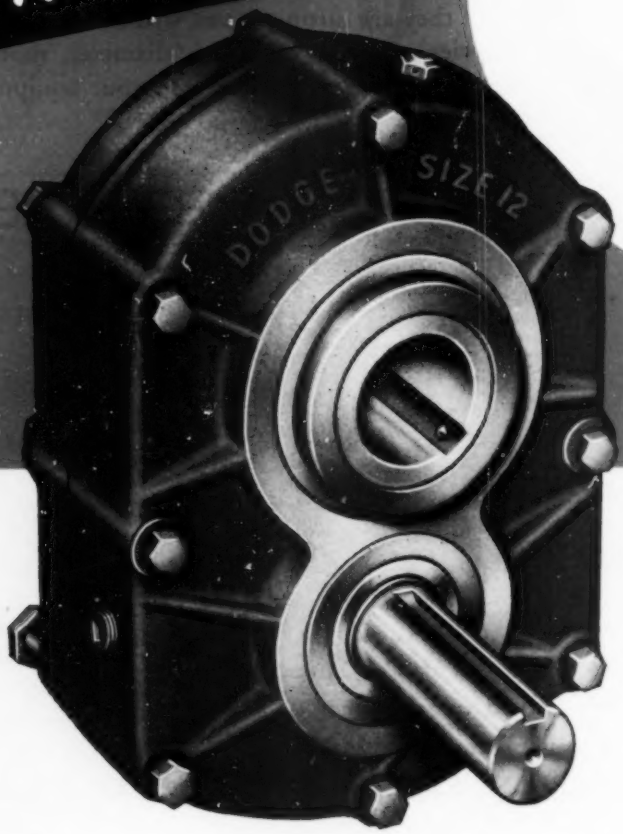

- Four sizes . . . all available from stock with stock product economy . . . with capacities up to 27 H.P. and developing output speeds from 115 to 330 r.p.m.
- No special engineering required. No foundation to provide. No flexible couplings. No sliding base. No "lining-up" difficulties. No expensive installation. Stock Taper-Lock sheaves prescribed for each job to provide desired speeds.
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- Backstop available from stock when required. Simple and positive. Easily installed on input shaft. Sealed from dust and dirt inside the reducer housing.
- The new Single Reduction TORQUE-ARM SPEED REDUCER is a DODGE product—which means fine engineering; quality manufacture. Get all the facts. WRITE for bulletin with selection tables.

115 to 330 R.P.M. TORQUE-ARM SPEED REDUCERS

HERE is a wholly new opportunity for important savings on drive reduction where requirements for output speeds range from 115 to 330 r.p.m. Dodge announces the first and only shaft-mounted reducer designed for these output speeds.

This new SINGLE REDUCTION Torque-Arm Speed Reducer provides the same big advantages in this range that its companion, the Double Reduction Torque-Arm, has brought to the field of lower speeds. It is practical and economical, easier to install and much more flexible in its application than floor mounted reducers.

Dodge SINGLE REDUCTION Torque-Arm Reducers can be delivered right from your Distributor's stock. Simply give him your horsepower requirement, the desired speed and size of the shaft to be driven, and he will furnish this complete speed reducer package to fit your job accurately.

Write us for Bulletin A602 with details, specifications and easy-to-use selection tables.

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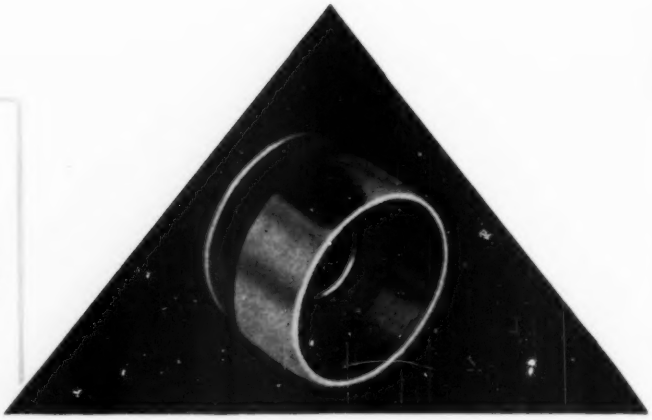
CALL THE TRANSMISSIONEER, your Dodge Distributor, for information on new ways to improve machine performance, cut costs. Look for his name under "Power Transmission Equipment" in your classified phone book.

AMERICA'S MOST COMPLETE LINE OF SHAFT-MOUNTED SPEED REDUCERS

POWDER METAL *is good in the clutch*



This centrifugal clutch assembly for fractional horsepower motor-drives was *designed* for powder metal production.

Cup and flange offer high friction properties because of the iron-base powder metal surface.

Shoes of leaded iron give maximum relative friction.

Porous leaded bronze bushings assure self-lubrication for the life of the part.

All this . . . and low cost too! Powder metal cost is far below that of all other manufacturing methods for this part.

Often powder metal production is ideal. Often a little redesigning suits a part for the powder metal process. Then the manufacturer gets the benefit of special characteristics, high production, fine tolerances without machining . . . and low cost.

Take nothing for granted however. Talk with experts . . . for example, Stokes engineers, who make no parts, but make the presses. Stokes will guide you in design and materials, calculate your savings, or refer you to a skilled powder metal processor.

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☐ *Our parts or blue prints are attached together with production requirements, for your analysis.*

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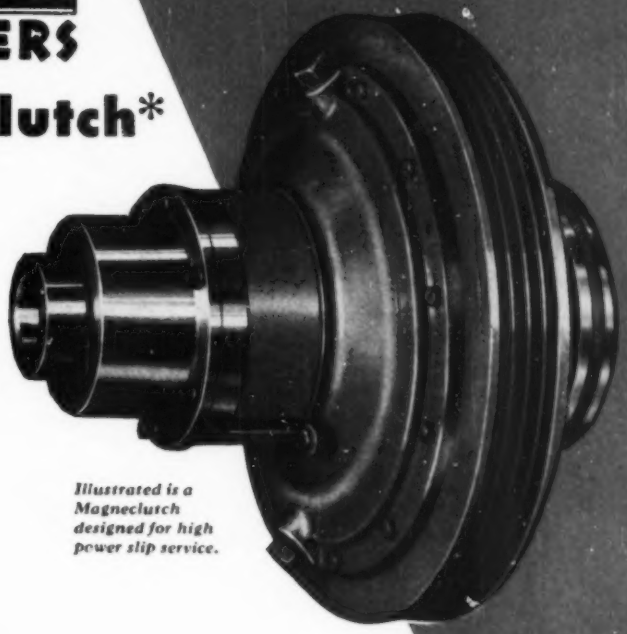
Parts illustrated were made by The Wel-Met Co., Kent, Ohio

TORQUE AT ZERO SLIP

...plus 7 other outstanding clutch advantages with a VICKERS Magneclutch*



Illustrated is a Magneclutch designed for high power slip service.

NEVER BEFORE in clutch history has *one* product offered all these design and operating features! Check them against your clutch requirements for SLIP SERVICE... BRAKING... ON-OFF or TORQUE SERVICE... TORQUE LIMITING... REVERSING DUTY.

- Dry magnetic torque medium
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- Small control power
- Easily adapted to remote control
- Electrically controlled

WRITE FOR BULLETIN 4000...it gives complete facts on the MAGNECLUTCH. Please make request on your letterhead.

*Trade-mark of Vickers Inc. for magnetic particle type clutches.

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VICKERS Inc.

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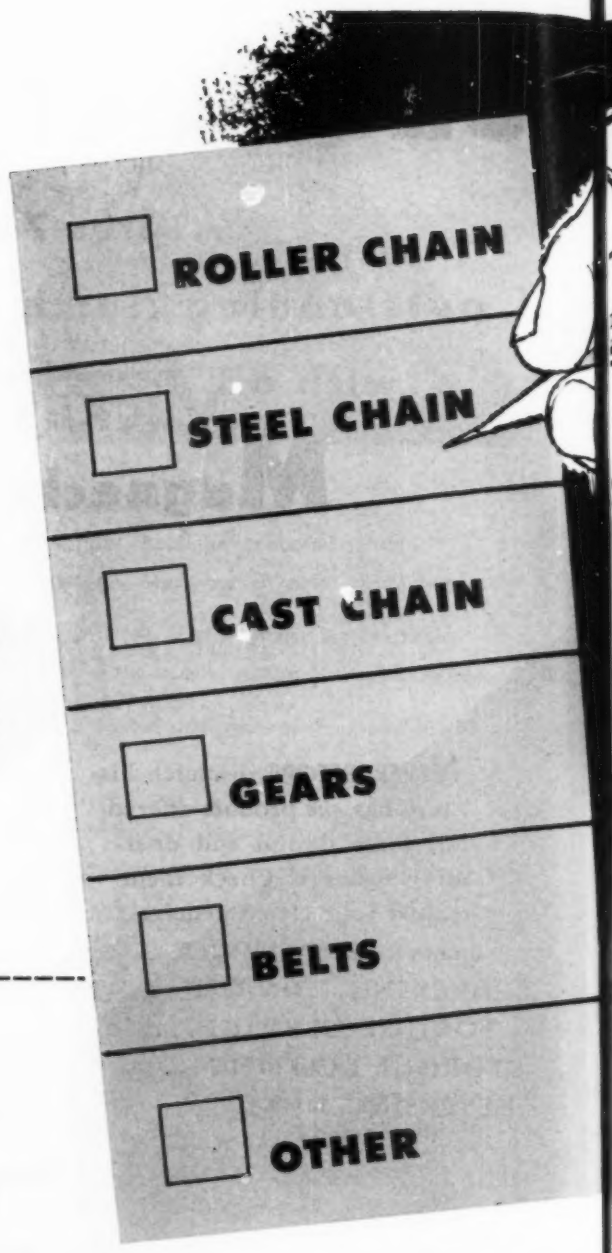

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. . . if you're designing for lower cost!

Let's consider your power transmission equipment. You know that substantial savings in first cost . . . in operating cost . . . in overall cost can be realized through proper selection and application of power transmission equipment in your machines.

There is no one best method for all equipment. BUT there is a *right* answer to *each* machine for driving, timing and conveying. In the complete Chain Belt line, you can find an answer to the vast majority of applications. Because they are not handicapped by the limitations of a limited line, Rex Field Sales Engineers can help you select the exact type of chain that is right for your machines . . . for lower costs all along the line.

Perhaps you have been using a finished roller chain, yet speed and load conditions are such that a cast chain or double-pitch roller chain will operate equally well at lower initial costs.

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Your equipment may be required to operate in dusty, dirty conditions. Chabelco Steel Chain can save you and your customers money here.

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The complete Chain Belt line provides a chain to exactly suit virtually every application. In those instances where belts or gears may be better, the Rex Field Sales Engineer can tell you why you should use these mediums for best results.

Chain Belt Company OF MILWAUKEE

Baldwin-Rex Standard Roller Chain

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Baldwin-Rex Double Pitch Roller Chain

Rex Chabelco Steel Chain

Rex TableTop® Conveyor Chain

Baldwin-Rex Leaf Chain

Your Rex Field Sales Engineer will be happy to consult with you regarding your application problems. He may be able to help you make substantial savings. Call or write your nearest Field Sales Office. Or, if you prefer, mail the coupon.

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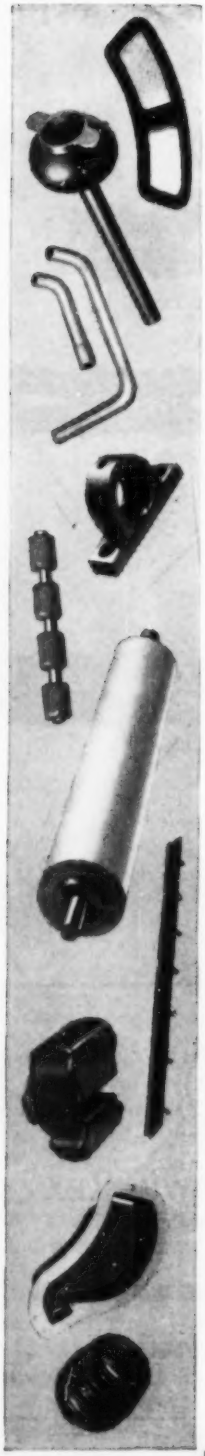

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Tyer technical knowledge and original thinking are available to you to make Rubber, *our* product, more useful to you in *your* product. The same know-how and resourcefulness that led Tyer to originate White Rubber and Elastic Webbing in the early days of the industry, have enabled Tyer, through war and peace, to supply American manufacturers with

THE UNUSUAL IN RUBBER
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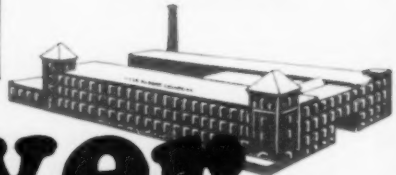

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RUBBER COMPANY
ANDOVER, MASSACHUSETTS

159 Duane St., **NEW YORK** 189 W. Madison St., **CHICAGO**
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KUNKLE SAFETY AND RELIEF VALVES

IF SAFETY VALVE
LEAKAGE
IS YOUR PROBLEM

. . . KUNKLE offers nylon and stainless steel equipped air and gas valves . . . LEAKPROOF at 93 to 96% of set pressures.

Bronze, iron and steel. Wide range of pressures and temperatures.

Write for Catalog and Capacity Data Covering Standard Items. Send Specifications and Inquiries For Special Assemblies to:

KUNKLE C.V.O. ESTABLISHED 1875

KUNKLE VALVE CO.
117 SO. CLINTON ST.
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miniature
COMPONENTS

SPEED CHANGERS only 1.050" diameter! Ratios from 10:9 to 3,375:1 *standard!* Specials to 2,000,000:1! Zero backlash and hobbed-gear types. Sealed construction, permanently lubricated. Ball-bearing input and output shafts. Ask for Bulletin 100.

VARIABLE SPEED DRIVE only 4 3/16" long. Infinitely variable speeds over 36:1 range. Smooth, accurate, stable adjustment. Permanently lubricated. Ball-bearings throughout. Speeds up to 20,000 RPM, nominal output .025 HP. Ask for Bulletin 99.

COMBINATION UNITS, variable and fixed ratio speed changers as integral units. Available for any motor input speed with adjustable output as low as a fraction of an RPM. Send us your combination requirements for detailed data.

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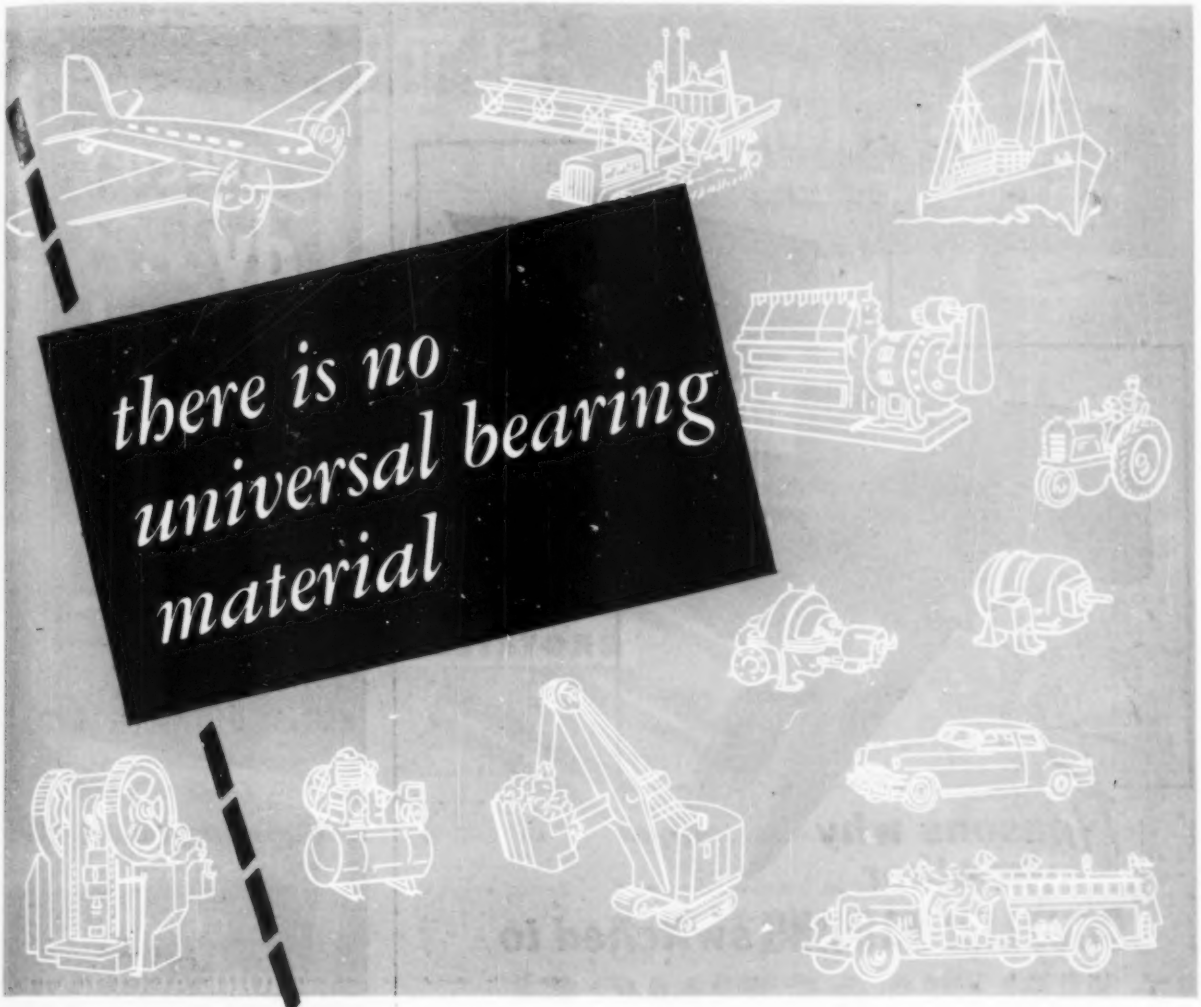

Silent
SLEEVE
BEARINGS

12 MACHINES

How many different Bearings?

There may be 20, 40 or more variations and combinations of alloys and designs in the sleeve bearings. One engine may require different bearing alloys for main bearings, connecting rod bearings, camshaft bearings, piston pin bushings and water pump bushings. That's one reason why, as long-time specialists in research, design and manufacture of sleeve bearings, we specialize in *variety*. Our seven manufacturing plants produce sleeve bearings and bushings in a wide range of material combinations and sizes, in quantities from dozens to millions.

Send for handy Bulletin for your reference file. It shows the "field of usefulness" for a wide range of bearing alloys, and provides a ready reference on bearing applications for your library.

FEDERAL-MOGUL CORPORATION, 11043 Shoemaker, Detroit 13, Michigan

FEDERAL-MOGUL

OVER FIFTY YEARS OF CONTINUOUS BEARING EXPERIENCE

IMPROVED APPEARANCE!
BETTER PERFORMANCE!
COSTS REDUCED 25%!

Reasons why another

COUPLER HOUSING *switched to*

UNITCASTINGS!

This warehouse trailer coupler housing is subjected to considerable stress and strain in handling materials for general factory use. As a weldment, it not only used 40 inches of welding, slowing down unit production, but lacked eye appeal.

After the switch to Unitcastings, production costs dropped 25%, trailer performance improved, a streamlined appearance added more "saleability" to the product . . . and with an eye to future repeat orders, Unitcastings created better customer relationships. To build quality into your own product, trust it to UNITCASTINGS—they're better.

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QUALITY STEEL CASTINGS

Give us a chance to offer a "cast steel" answer for your parts problem. Our suggestions while your product is in the design stage will pay continuous dividends. Write or call today. Unitcast Corporation, Steel Casting Division, Toledo 9, Ohio. *In Canada:* Canadian-Unitcast Steel, Ltd., Sherbrooke, Quebec.

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Simplified Non-Destructive Testing . . .
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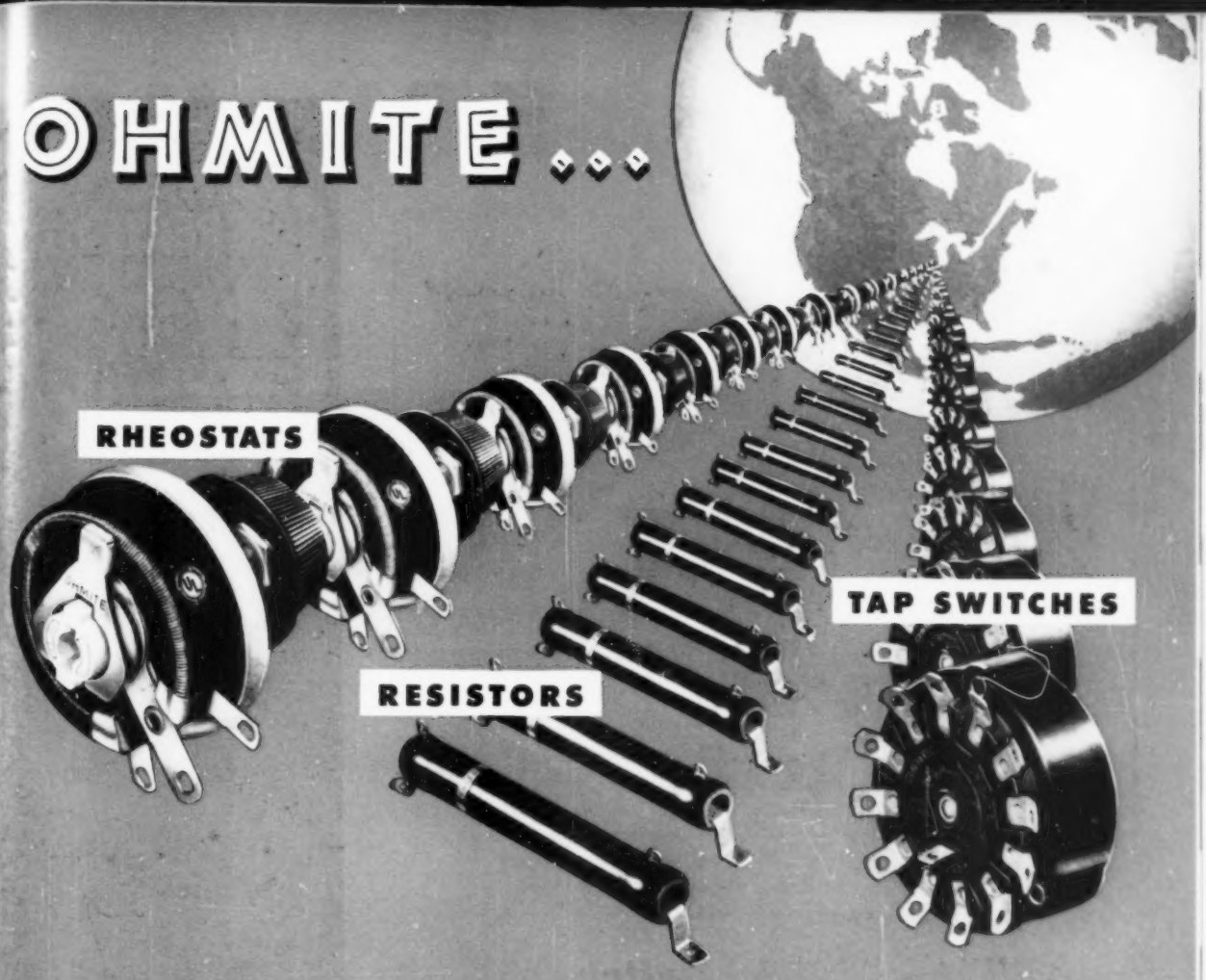
OHMITE...



World Renowned for Dependability

To thousands of equipment manufacturers the world over—the name OHMITE has become synonymous with *QUALITY*. These manufacturers have put OHMITE resistance products through the most rigid of all tests—performance in the field—and these superior units have provided consistently dependable performance and long life under the most difficult operating conditions.

"Be Right with OHMITE" is more than just a slogan to these users. They know that when they specify OHMITE, they get the finest resistance equipment available—anywhere!

RESISTANCE PROBLEMS?

—let experienced OHMITE engineers solve them for you!

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Be Right with **OHMITE**
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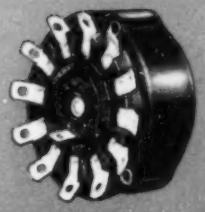
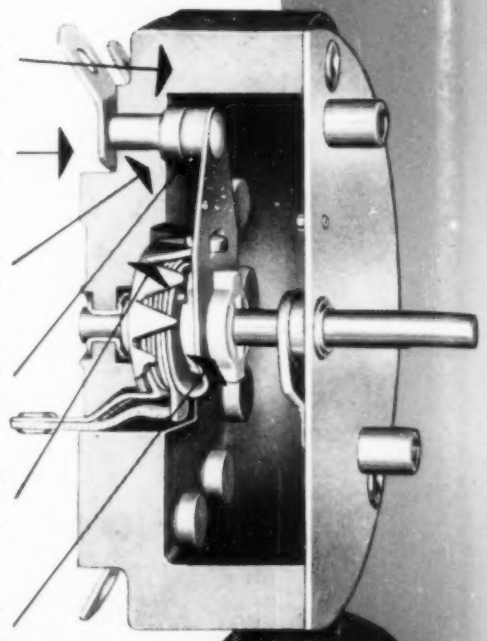
RHEOSTATS RESISTORS TAP SWITCHES



OHMITE *High-Current, Rotary* TAP SWITCHES

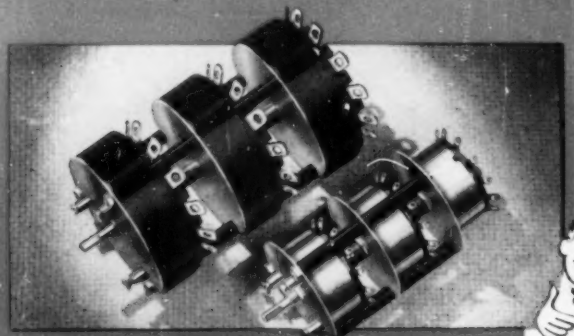
—PREFERRED THROUGHOUT INDUSTRY

1. **CERAMIC CONSTRUCTION** provides perfect insulation, unaffected by arcing. Contacts and mechanism are entirely enclosed and protected (except for Model 111).
2. **EXTREMELY COMPACT,** yet have many high-current taps, perfectly insulated. Terminals are convenient for wiring. Back-of-panel mounting.
3. **SILVER-TO-SILVER CONTACTS,** for high electrical conductivity. Have low surface resistance, and eliminate contact maintenance.
4. **SELF-CLEANING ROTOR CONTACT.** Slightly rounded, assuring perfect seating and producing slight rubbing motion with every operation.
5. **"SLOW-BREAK" MECHANISM,** incorporating a positive cam-and-roller. Provides "slow-break, quick-make" action, particularly suited to alternating current. Minimizes sparking, extends contact life.
6. **"DEAD" SWITCH SHAFT.** Completely insulated from the load by a high-strength driving hub which will withstand a 2000-volt test.



5 SIZES
10 to 100 Amp.
A-C

AVAILABLE IN TANDEM MOUNTINGS



Have many applications, including simultaneous control of separate circuits. Extended shafts, with universal coupling for single-knob control of two or three switches.

Write on Company Letterhead for Catalog and Engineering Manual No. 40.

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RHEOSTATS • RESISTORS
TAP SWITCHES

No need for *trial and error* here

—when you have a friction materials problem, call Johns-Manville

A PHONE CALL—or a letter—to your nearest Johns-Manville office can save days or weeks of precious time . . . whenever you have a design problem involving friction materials.

Our field engineers are able and willing to give you valuable information on the entire range of friction materials. They will quickly help you select the *right* material for your job.

Johns-Manville can give you this service because:

1. We are pioneers in the manufacture of friction materials.

2. We have accumulated a broad background of experience by supplying friction materials to practically every industry.

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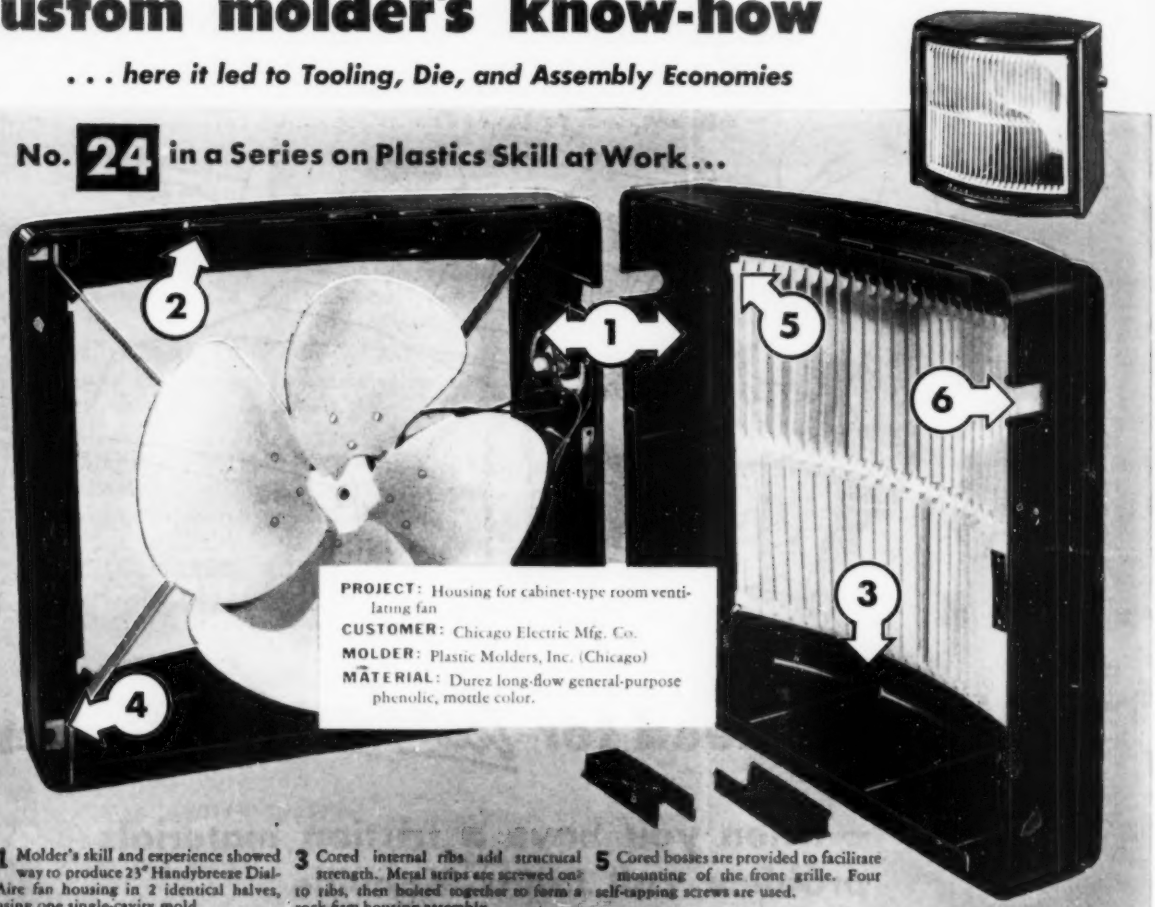
So when you have *any* problem in connection with friction materials . . . for use on shovels, draglines, hoists, winches, cranes, presses . . . or any type of clutch or brake on any mechanism, call us. We'll be glad to give you the benefit of our experience. Why not write for the booklet FM-12A, which will show you comprehensively how we can help you? Write to Johns-Manville, Box 290, New York 16, N. Y.

Johns-Manville *Industrial* **FRICTION MATERIALS**

It pays to use your custom molder's know-how

. . . here it led to Tooling, Die, and Assembly Economies

No. 24 in a Series on Plastics Skill at Work...



1 Molder's skill and experience showed way to produce 23" Handybreeze Dial-Aire fan housing in 2 identical halves, using one single-cavity mold.

2 Alternating groups of tongue and groove sections along the inner edges (4 male and 4 female repeated) form a secure hidden joint.

3 Cored internal ribs add structural strength. Metal strips are screwed on to ribs, then bolted together to form a rock-firm housing assembly.

4 Molded-in metal inserts at the four corners support the fan and motor assembly. Insulated with rubber grommets, they provide a floating mount.

5 Cored bosses are provided to facilitate mounting of the front grille. Four self-tapping screws are used.

6 Convenient handles are formed by two side slots on each molding. Spring-fitting safety guards serve to protect the mechanism.

● A good way to wrap up and forget numerous manufacturing problems is to combine the all-round ingenuity of a good custom molder and the all-round properties of Durez phenolic plastics.

You may save time and money . . . by-pass finishing operations . . . make your product look better and serve better. This king-size fan housing shows very well what we mean.

Through imaginative tooling, the molder made it possible to produce both halves of the complete cabinet from one single-cavity mold. This approach held the tooling period and die costs to a minimum. Ingenious provision for fitting the pieces together produced an easily assembled job with the great rigidity a large portable fan should have.

Despite its size... it is molded from an 18-pound charge, and measures 20"x 23"x 14" assembled . . . the Durez cabinet has high dimensional stability.

Durez comes from the mold with a beautiful lustrous "molded-in" finish and seldom requires costly fabrication or finishing operations. Its excellent mechanical, electrical, and chemical properties are available in a wide variety of combinations for particular needs.

Use your molder's know-how when you plan for low-cost, time-saving production. And call on the wide experience of Durez phenolics technicians without obligation.

Our monthly "Durez Plastics News" contains many useful ideas. May we place you on the list? Durez Plastics & Chemicals, Inc. 2012 Walck Rd., N. Tonawanda, N. Y.

DUREZ

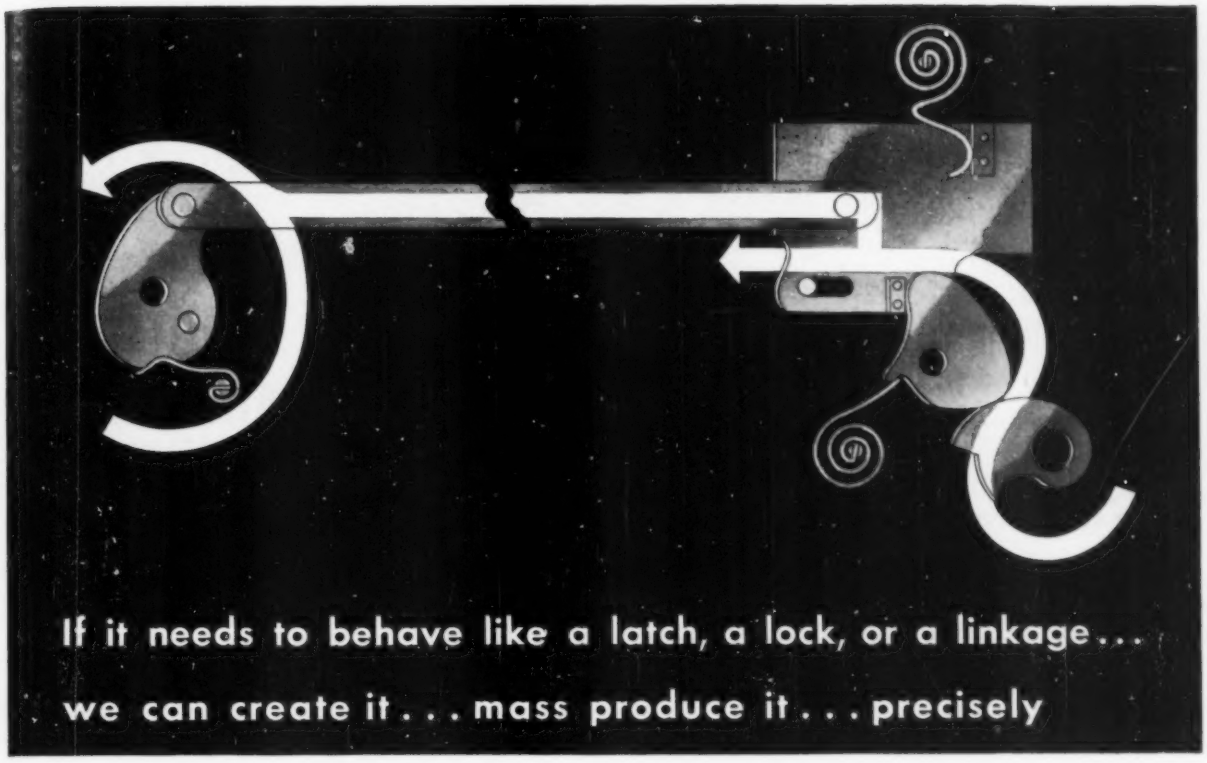
PHENOLIC RESINS

MOLDING COMPOUNDS

INDUSTRIAL RESINS

PROTECTIVE COATING RESINS

PHENOLIC PLASTICS THAT FIT THE JOB



If it needs to behave like a latch, a lock, or a linkage...

we can create it . . . mass produce it . . . precisely

. . . WITH STAMPINGS!

What's to be gained with a well-designed mechanical motion?

Often, better performance. Often, greater safety. Often, more operating convenience. A properly designed motion can frequently improve *all* of these and therefore, your product's sales appeal.

How do you put such things into a motion? Should it operate by a spring, a cam, a lever, or a pedal? Does it latch, lock, catch, or trip? Must it slide, swing or rotate? Will it be subjected to excessive vibration? Must it be concealed? Our engineering staff has answered these questions for a number of customers, and designed devices to meet their particular set of conditions.

When it comes to manufacturing, we mass produce such devices by *stamping* to keep the cost very low. Out of our experience, we have developed a variety of quality control techniques for holding assembly to unusually close tolerances.

If this design experience and our careful manufacturing approach suggest new product possibilities to you, they can be put to work on your problem. Our engineers would be happy to discuss it with you.

Our new booklet, "We Make Motions", explains our facilities further. Why not write for your copy today?

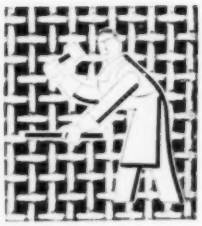
THE REID DIVISION OF *The Standard Products Co.*

THE MARK OF A SUPERIOR PRODUCT

DEPT. D, GENERAL OFFICES: 2130 WEST 110 STREET • CLEVELAND 2, OHIO

WE MAKE MOTIONS

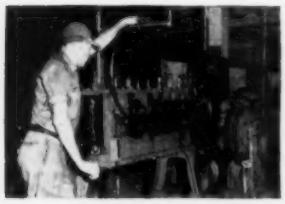
At your Service

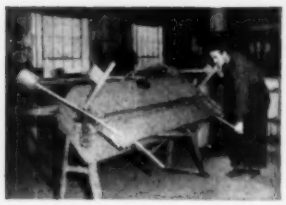


ON WIRE AND METAL ASSEMBLIES

CAMBRIDGE offers the most modern fabricating facilities plus years of engineering experience

. . . to make any wire and sheet metal tray, rack, basket, fixture, crate, screen or other fabrication you need to reduce costs and speed-up material handling, processing and treating. The fact that Cambridge is equipped to perform every step of the designing and manufacturing assures you of the famous Cambridge quality and service on all items, regardless of size or quantity.





Your Cambridge field engineer can recommend the right design and construction, and the proper metal or alloy for washing, spraying, dipping and similar operations.

Or write direct for information on the complete Cambridge facilities. Send for this FREE illustrated folder describing Cambridge wire baskets and specialties.

Cambridge Wire Cloth Co.

Wire cloth in rolls. | Any metal or alloy, mesh or weave.

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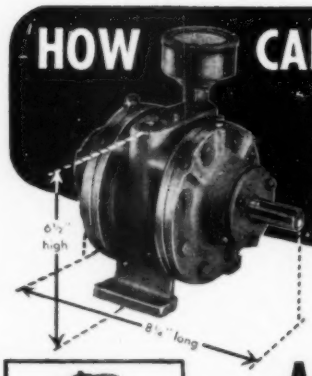
See "Baskets, Wire" in your Classified Telephone Directory

HOW CAN YOU USE this GAST 3 h.p. ROTARY AIR MOTOR?



This style for flange mounting.

See our CATALOG in SWEET'S FILE for product designers

"AIR MAY BE YOUR ANSWER!"

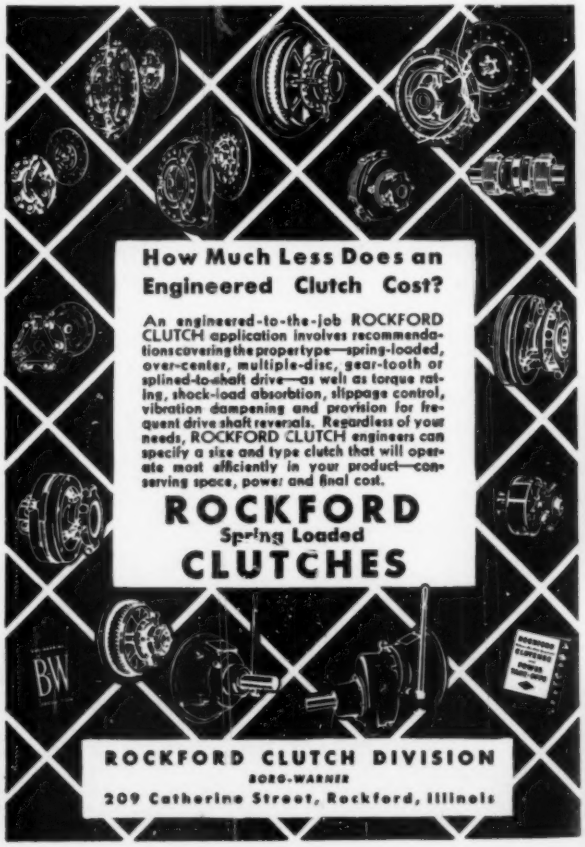
On your present products — or those now being designed — you may gain outstanding advantages by using this *larger* GAST No. 8 Air Motor.

Built on the famous GAST rotary-vane principle, the No. 8 delivers variable-speed power with simple valve control. It's explosion proof . . . it can't burn out from overloads . . . and it delivers a smooth 3 h.p. at 1500 r.p.m. *with a weight of only 25 pounds!*

Investigate this unique, compact motor now — it may provide unusual advantages for your application.

Write for new bulletin AM-8 and complete specifications — today!

GAST ROTARY — AIR MOTORS · COMPRESSORS · VACUUM PUMPS
(TO THREE H.P.) (TO 30 LBS.) (TO 28 INCHES)
GAST MANUFACTURING CORP., 138 Hinkley St., Benton Harbor, Mich.



How Much Less Does an Engineered Clutch Cost?

An engineered-to-the-job ROCKFORD CLUTCH application involves recommendations covering the proper type—spring-loaded, over-center, multiple-disc, gear-tooth or splined-to-shaft drive—as well as torque rating, shock-load absorption, slippage control, vibration dampening and provision for frequent drive shaft reversals. Regardless of your needs, ROCKFORD CLUTCH engineers can specify a size and type clutch that will operate most efficiently in your product—conserving space, power and final cost.

ROCKFORD
Spring Loaded
CLUTCHES

ROCKFORD CLUTCH DIVISION
BORG-WARNER
209 Catherine Street, Rockford, Illinois

Here's How You Save Time and Money with Townsend Fasteners and Parts.

The items shown here are examples of how others, through slight changes in

design or by switching from expensive screw machine items to Townsend cold

headed fasteners and parts have improved their product, speeded operation,

and cut costs. To check your costs send us samples or sketches and we will

suggest how you get better parts faster, for less money from Townsend. Write:

Townsend

COMPANY — ESTABLISHED 1816

New Brighton, Pa.
Chicago 38, Ill.

PROBLEM: Outboard bearings on extended pin roller chain conveyor . . . to withstand degreasing vapor, dipping bath fumes, high heat, water dip, steam, acid spray, etc.

SOLUTION: A Morganite bearing . . . the special bearing for special conditions . . . meets all requirements . . . is entirely self-lubricating under all conditions.

SELF-LUBRICATING MORGANITE OUTBOARD BEARINGS ON CONVEYOR BELT ROLLER CHAIN

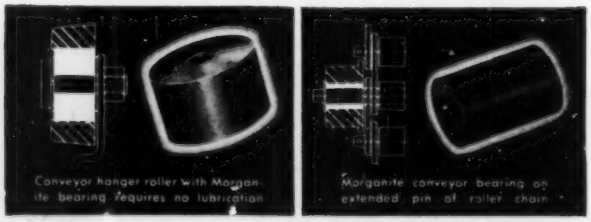
MORGANITE
SELF-LUBRICATING
CARBON BEARINGS

One application that clearly demonstrates the special properties of Morganite bearings is their use on conveyor belts involving continuous changes of atmosphere and temperature. Bearings, pump blades and seal rings of Morganite easily withstand these conditions . . . actually operate better when submerged in liquids. They are immune to oil, petroleum, water, brine, most acids and alkalies. Being self-lubricating they do not contaminate contacting liquids and materials with grease or oil, impart no odor or taste.

See our CATALOG in SWEET'S FILE

Additional data on Morganite will be found in Sweet's File for Product Designers. For competent engineering help on specific problems consult a Morganite sales engineer. There is no obligation.

REGISTERED TRADE MARK **Morganite** INCORPORATED
LONG ISLAND CITY 1, NEW YORK


Conveyor hanger roller with Morganite bearing requires no lubrication
Morganite conveyor bearing on extended pin of roller chain

Manufacturers of Morganite Carbon Brushes for all motor and generator applications, and Morganite Carbon Piles.

Precision made to order molded rubber products

Manufactured To Your Specifications

Here, with excellent facilities and years of experience, we are prepared to manufacture molded parts of natural or synthetic, sponge or solid rubber, to customer specifications.

Rubber couplings, pads, gaskets, valve discs, cushions and blocks are but a few of the many items regularly manufactured. Write outlining your requirements or, better still, send us your blueprints.

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VAN CLEEF BROS. INC.
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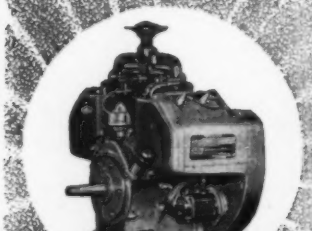
CHICAGO, 19, U. S. A.

Preferred for
PEAK PERFORMANCE
15 to 30 H. P
V-Type Four-Cylinder
WISCONSIN
HEAVY-DUTY *Air-Cooled* **ENGINES**



Model VE-4, V-type 4-cylinder standard engine 21.5 hp. at 2400 rpm.

On power jobs that call for rugged serviceability and sustained operation in the 15 to 30 hp. range, Wisconsin 4-cylinder engines rate *first preference* on the basis of such features as:

Trouble-free Air-Cooling at all temperatures from sub-zero to tropical highs; tapered roller bearings at BOTH ends of the extended crankshaft to take up all thrust and radial loads (also inherently self-cleaning); rotary type, high tension OUTSIDE Magneto equipped with Impulse Coupling for quick starting in any weather and sure firing on the job; individual oil stream to each connecting rod (other parts lubricated by oil spray) assuring complete and thorough lubrication at all times.

V-type design permits a shorter crankshaft and less height than with a "straight-in-line" engine, assuring a more compact power unit.

4-cycle single cylinder models, 3 to 9 hp., and 2-cylinder models, 7 to 13 hp., also available. Detailed data on request.

MOST H.P. HOURS

WISCONSIN MOTOR CORPORATION
World's Largest Builder of Heavy-Duty Air-Cooled Engines
MILWAUKEE 14, WISCONSIN

NEW...

16-Page Booklet on PLEXIGLAS Molding Powders

Send for your copy

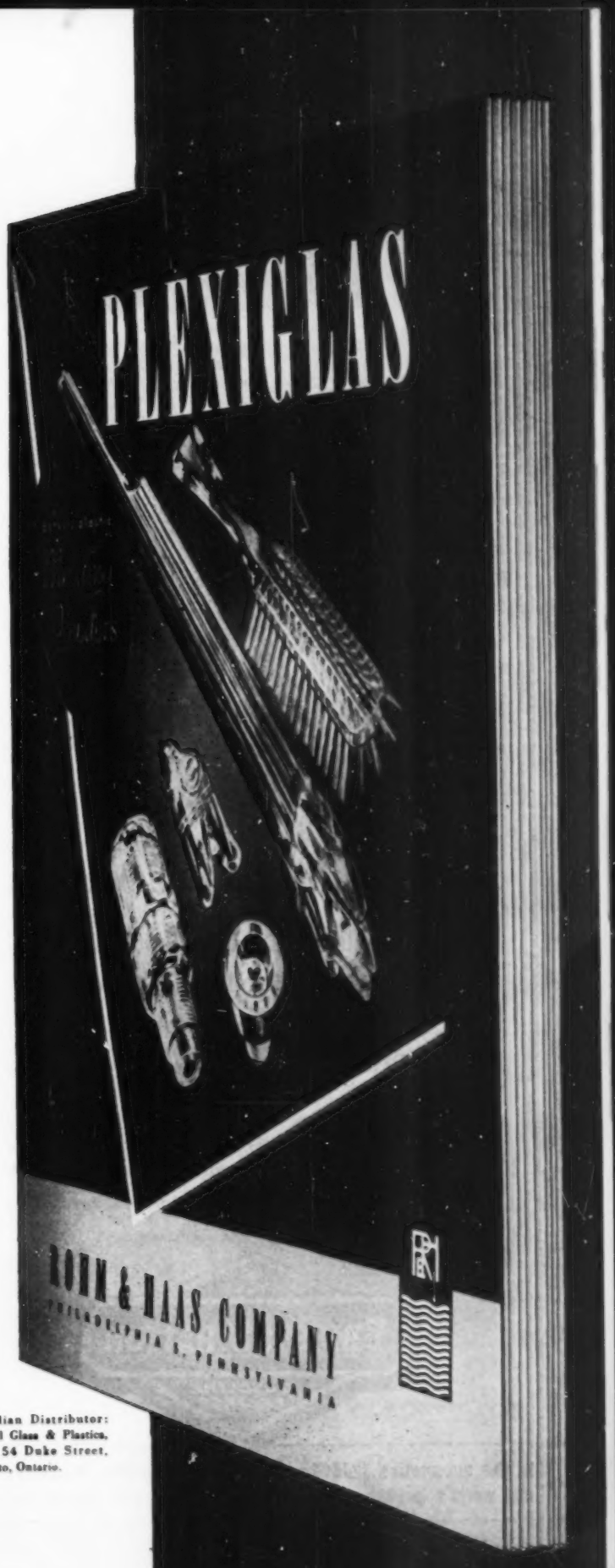
Specially prepared for plastics molders, this file-size booklet summarizes the up-to-date information you need on acrylic molding powders.

Its 16 concise, readable pages—fully illustrated with photographs and drawings—include a complete 2-page tabular digest of PLEXIGLAS physical properties, as well as helpful pointers on the application of specific PLEXIGLAS Molding Powders to various types of jobs.

For easier, more economical molding of industrial and automotive parts, signs and sign letters, household decorations and accessories—it will pay you to have on file this handy guide and reference booklet. A request on your business letterhead will bring you your free copy.

Write to Department MP

PLEXIGLAS is a trade-mark, Reg. U. S. Pat. Off. and in principal foreign countries.



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ROHM & HAAS COMPANY

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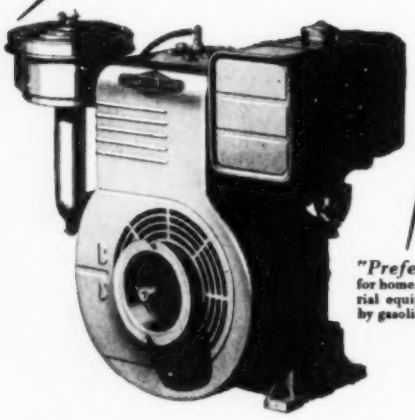
Precision

IN AIR-COOLED POWER



"Preferred Power" for home, farm and industrial equipment — powered by gasoline engines.

Precision at every step:

- ✔ **Precision Control of Materials**
- ✔ **Precision Production Tools**
- ✔ **Precision Workmanship**
- ✔ **Precision Inspection**

That's why owners want Briggs & Stratton single-cylinder, 4-cycle, air-cooled engines—the finest ever built—on their gasoline-engine powered equipment.

BRIGGS & STRATTON CORP., Milwaukee 1, Wis., U.S.A.

4 CYCLE
BRIGGS & STRATTON
GASOLINE ENGINES
World Wide FACTORY SUPERVISED SERVICE

In the automotive field Briggs & Stratton is the recognized leader and world's largest producer of locks, keys and related equipment.

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LOW CARBON
HIGH CARBON
STAINLESS
SPECIAL ALLOY
ARMCO IRON

ROUND
FLAT
OR
SHAPED

You draw the Shape
—Page can draw the Wire

—the way you want it for your production—whether it's ALL of your product, or only a part.

Cross-sectional areas up to .250" square; widths to ⅜"; width-to-thickness ratio not exceeding 6 to 1.

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AMERICAN CHAIN & CABLE

ANCHOR

Assembled Hydraulic Hose Units

Tailor-made to Keep Your Costs Down–Performance Up

Factory-assembled to your specifications—save you time and money, give you a better job

For extra protection against leaks and blow-offs at high pressures use factory-applied Anchor Ductile Sleeve Hose Couplings with their exclusive patented grip.

FOR longer service life — you design your machines with great care and manufacture them to rigid tolerances.

But the job is not done until you invest the same care in selecting and specifying hose units. After all, the performance of your machines is dependent upon them.

That's why Anchor offers factory-assembled hose units. They are made to exact lengths in accordance with your drawings. And the couplings are factory-applied by experts with specially designed machines to give you leakproof dependability and extra safety. They cost less in the long run — because they give better service, keep your customers satisfied.

Shown here is a rayon two-braid hose-assembly designed for medium and low pressures. Made from specially selected synthetic rubber, it has excellent flexibility. This same unit is also available in a single-wire braid hose.

For high pressures Anchor Ductile-sleeve hose-couplings are your best choice.

Take out performance insurance. Reduce assembly time and costs in your plant and in the field. Equip your machines with Anchor factory-assembled hose units.

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I like the dependability, the safety, and the time-and-money-saving features of Anchor Assembled Hose Units. Please send me Bulletin No. 488.

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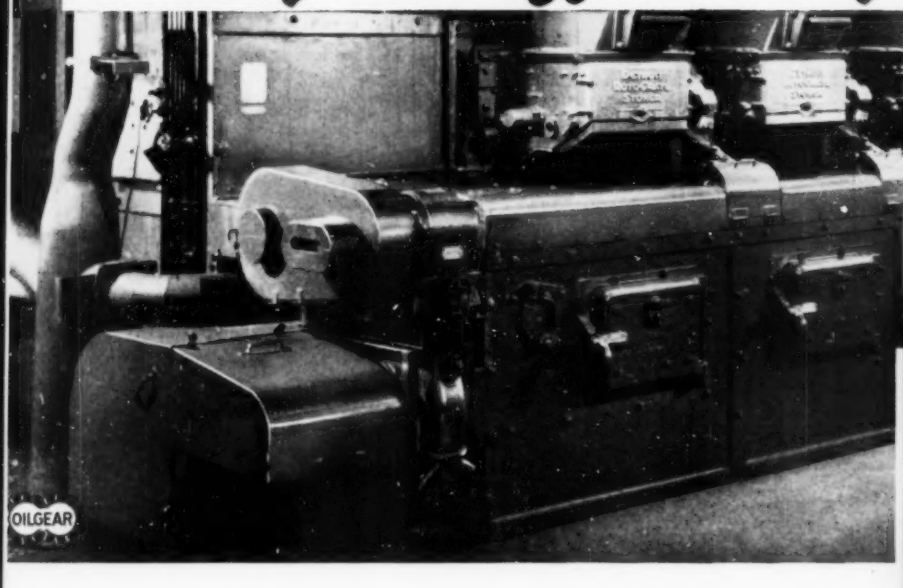
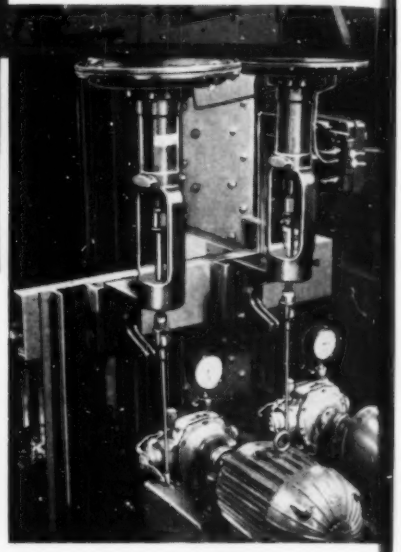
P-2

ANCHOR COUPLING CO. INC.
Factory Libertyville, Illinois • Branch Detroit, Michigan

"ONE OF THE *Highest Efficiency Units*" IN THE UNITED STATES



View in J. I. Case Co. tractor works at Racine, Wis. Boiler front and Detroit Roto-Grate Stoker on 100,000 lb. per hr. boiler unit



And Oilgear's Range and Control help capture savings hidden in J. I. Case 100,000 lb. Boiler Unit

The 100,000 lb. per hour boiler unit in the J. I. Case Co. tractor works at Racine, Wisconsin, has demonstrated that it is one of the highest efficiency units in the United States. To obtain such high efficiency, careful tests of variable speed drives for fuel feed and grate travel were made during two years. Finally, Case engineers selected Oilgear Fluid Power Drives, for, as Mr. Cole H. Morrow, Chief Plant Engineer says, the Oilgear units proved far superior to electric drives and mechanical transmissions under actual operating conditions.

SMOOTH, POSITIVE SPEED VARIATION "In order to obtain high efficiency in any boiler unit," says Mr. Morrow, "*a very precise variable speed fuel feed drive* is required to meet widely varying demand. The Oilgear Drive gives smooth, positive variable speed operation from zero to 100% of capacity with a straight line fuel feed characteristic. This allows us to calibrate the control system for operation within amazingly close limits of fuel-air ratio variation.

EASE OF CONTROL "Also, on this type of stoker the grate speed must be infinitely variable from minimum to maximum yet maintained in direct proportion to the rate of fuel feed. Every change in fuel feed requires an immediate and directly proportionate change in grate speed. (Such synchronization) is easily obtained with the Oilgear drive units because of their ease of control, and the simplicity and low force requirements of the control mechanism."

UNLIMITED SPEED RANGE Also, fuel feed and grate drives must have a range of speed at least equal to the demand range. Most drives have a range not exceeding 4 to one. Yet at Racine, during the summer, demand drops far below the 25,000 lb. threshold imposed by such a ratio. The Oilgear Drives however have no "ratio" limits, would function down to zero load if necessary. In fact, they give precise load control down to a load of 15,000 pounds per hour normally obtained each day during the summer, and down to as low as 5,000 pph over the weekends still under full automatic control.

OUTSTANDING RELIABILITY "One of the outstanding features we discovered . . . was the *reliability of the Oilgear units*. The experimental installation operated almost continuously for a year and a half without any difficulty. This record was far better than we were able to obtain with any other type of drive or transmission."

These four features, variability, ease of synchronization and control, actual range from zero fpm, rpm or torque up to maxim and reliability proven over and over again, indications of the many advantages Oil drives and transmissions offer in mac design and use. Investigate Oilgear eq ment as a *better* solution for your probl THE OILGEAR COMPANY, 1571 W Pierce Street, Milwaukee 4, Wisconsin.

Two Oilgear Variable Delivery Pumps with si diaphragm actuated hydraulic servomotor l controls supply fluid power for the fuel feed grate drives. An Oilgear drive was experiment installed on the fuel feed on the first stoker in 19 On the basis of its performance, Oilgear dr were used for *both* fuel feed and traveling grat a second stoker unit installed in 1949. Also, gear will replace the mechanical grate drive the first stoker installed in 1943. Like a shad flexible, controllable Oilgear *Fluid* Power ca fuel feed rate and grate speed to accompany st demand up and down. Recording charts s steam *demand* varies "all over the place," steam pressure and fuel air ratio stay steady.

Oilgear

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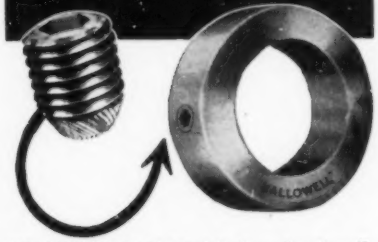

HALLOWELL Solid Steel Collars, functionally proportioned throughout . . . precision-machined so faces run perfectly true . . . are beautifully polished all over . . . yet they cost less than common cast iron collars. 3" bore and smaller are made from Solid Bar Stock. To make sure the collar won't shift on the shaft, they are fitted with the famous UNBRAKO Knurled Point Self-Locking Socket Set Screw — the set screw that won't shake loose when once tightened. HALLOWELL . . . a "buy word" in shaft collars . . . available in a full range of sizes for IMMEDIATE DELIVERY.

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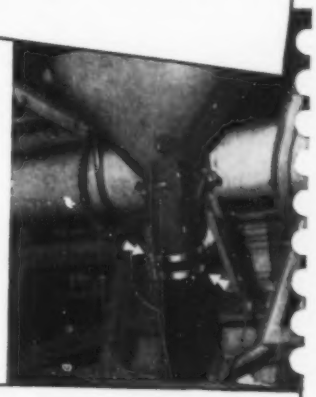
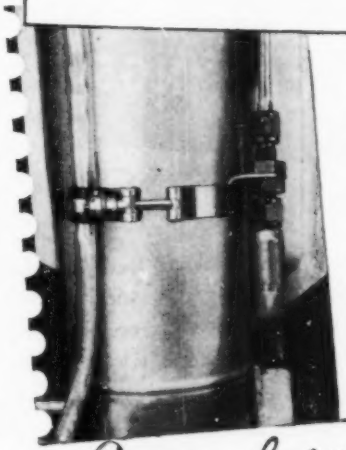
TO CLAMP SYNTHETIC RUBBER TUBE TO BEADED DUCT

MARMAN UNIVERSAL CLAMPS CONNECT FLEXIBLE DRAINAGE TUBE TO STAINLESS STEEL OUTLET. CLAMP ESPECIALLY RECOMMENDED FOR INSTALLATIONS WHERE HEAVY VIBRATION, IRREGULAR SHAPE AND CORROSION ARE FACTORS.





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MARMAN T-BOLT CLAMP USED IN CONJUNCTION WITH HARNESS CLIP AND BRACKET PROVIDES EFFICIENT MEANS TO ATTACH ELECTRICAL AND HYDRAULIC LINES TO LANDING GEAR STRUT. THIS ASSEMBLY PROVIDES HIGH SECURITY AGAINST VIBRATION WITH MINIMUM COMPLEXITY.

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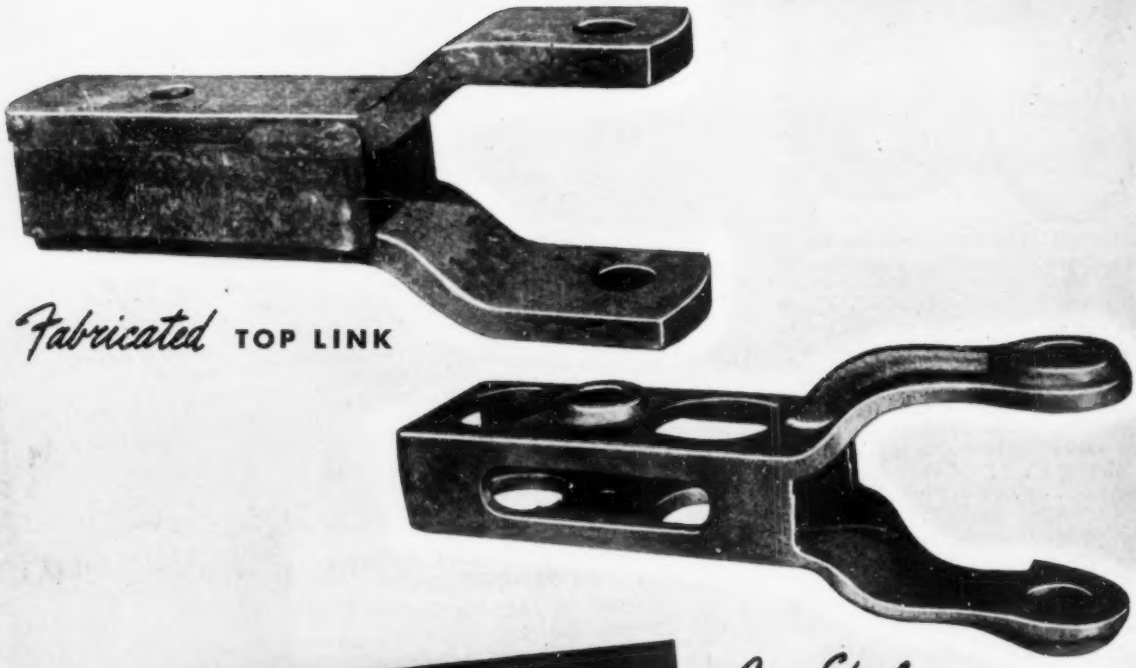

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Cast Steel TOP LINK

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WEIGHT REDUCED 57%
WITH STEEL CASTINGS

This is a component of a universal joint for a farm implement. It originally was produced by welding together two hinge arms — sheared from ½" by 2-1/16" plate, drilled and formed — and two side members, from ⅜" by 1¼" stock.

Conversion to a *foundry engineered* steel casting resulted in a three-way improvement — 6% lower cost; 57% weight reduction (7 lbs. to 3 lbs.) and greatly improved appearance... important because the part is on top of the implement and completely exposed.

* * *

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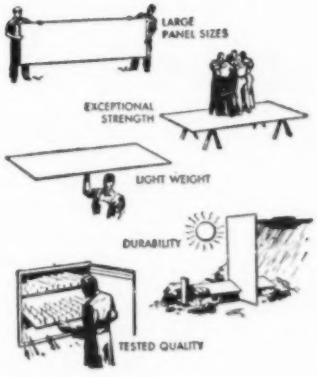

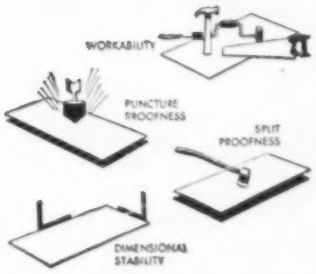

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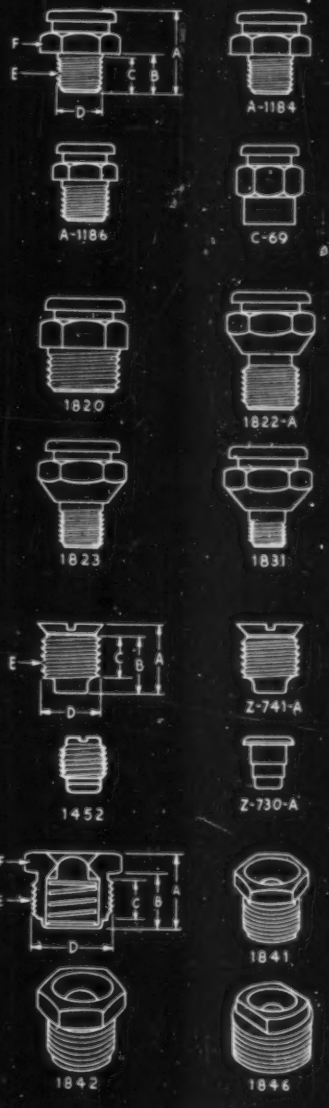

STANDARD BUTTON HEAD FITTINGS

Part No.	DIMENSIONS A	B	C	D	E	F*
C-69	29/32"	13/32"	9/32"	39/64"	1/8" P.T. Female	5/16"
A-1184	33/64"	11/32"	19/64"	13/32"	1/8" P.T.	5/16"
A-1186	53/64"	27/64"	5/16"	35/64"	1/4" P.T.	5/16"
A-1188	61/64"	31/64"	27/64"	43/64"	3/8" P.T.	3/8"
A-1190	1 5/64"	35/64"	31/64"	27/32"	1/2" P.T.	7/16"
1396	1"	1/2"	13/32"	43/64"	3/8" P.T.	3/8"
1401	53/64"	27/64"	5/16"	35/64"	1/4" P.T.	5/16"

*Wrench Size.

GIANT BUTTON HEAD FITTINGS

Part No.	DIMENSIONS A	B	C	D	E	F*
1820	11/16"	1/2"	13/32"	27/32"	1/2" P.T.	7/8"
1821	15/16"	9/16"	7/16"	5/8"	5/8"-18 Thd.	7/8"
1822-A	15/16"	9/16"	29/64"	43/64"	3/8" Spec. P.T.	7/8"
1823	1 1/4"	1/2"	5/16"	35/64"	1/4" P.T.	7/8"
1825	2"	41/64"	11/32"	43/64"	3/8" P.T.	7/8"
1831	15/32"	5/8"	9/32"	13/32"	1/8" P.T.	7/8"
**1871-A	15/16"	9/16"	29/64"	43/64"	3/8" P.T.	7/8"
**1872-A	1 1/4"	1/2"	5/16"	35/64"	1/4" P.T.	7/8"

*Wrench Size. **1871-A and 1872-A have special construction to withstand extremely high pressures. Recommended for use on lubricated valves.

FLUSH TYPE FITTINGS

Model No.	A	B	C	D	E
†Z-730-A	7/16"	3/8"	.....	5/16"	.....
Z-741-A	9/16"	15/32"	7/16"	35/64"	1/4" P.T.
1452	1/2"	29/64"	29/64"	13/32"	1/8" P.T.
†1814	21/64"	9/32"	.....	5/16"	.....
1815	23/64"	9/32"	9/32"	13/32"	1/8" P.T.
†1817	11/32"	19/64"	.....	3/8"	.....
†1853	11/32"	19/64"	.....	1/4"	.....

†Drive Fittings.

GIANT FLUSH TYPE FITTINGS

Model No.	A	B	C	D	E	F*
1840	49/64"	39/64"	31/64"	5/8"	5/8"-11 Thread	3/4"
1841	49/64"	39/64"	31/64"	43/64"	3/8" P.T.	3/4"
1842	55/64"	39/64"	1/2"	27/32"	1/2" P.T.	7/8"
1843	7/8"	39/64"	1/2"	1 3/64"	3/4" P.T.	1 1/8"
1844	7/8"	5/8"	31/64"	1 5/16"	1" P.T.	1 3/8"
**1846	49/64"	19/32"	19/32"	1 3/64"	3/4" P.T.	11/16"
**1847	55/64"	39/64"	1/2"	27/32"	1/2" P.T.	3/4"

*Wrench Size. **Flush Fit No Hex.

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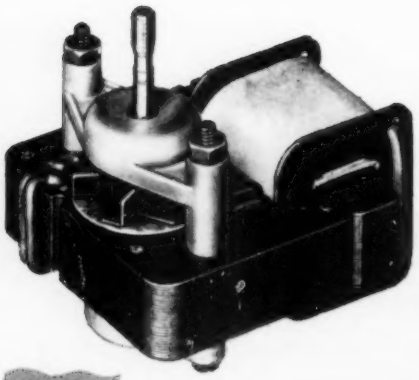

MODEL A

2-pole, shaded pole induction motor. Choice of three field thicknesses to meet varying requirements between 1/125 and 1/200 H.P. Features include novel bearing construction which insures rigid and permanent alignment of motor shaft . . . oilless bearings.

MODEL C

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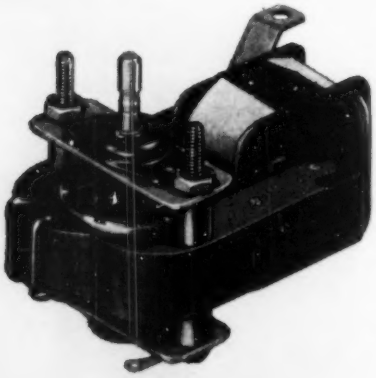

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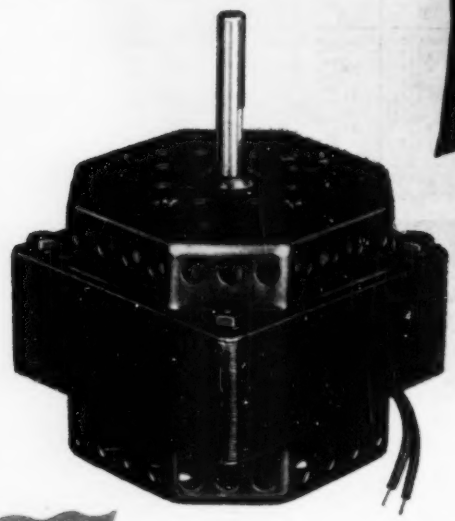

MODEL D

4-pole, shaded pole induction motor. Choice of three field thicknesses to meet varying requirements between 1/50 and 1/100 H.P. Features include scientifically designed air intake . . . dual cooling fans . . . self-aligning, oilless sleeve bearings . . . dynamically-balanced rotor.

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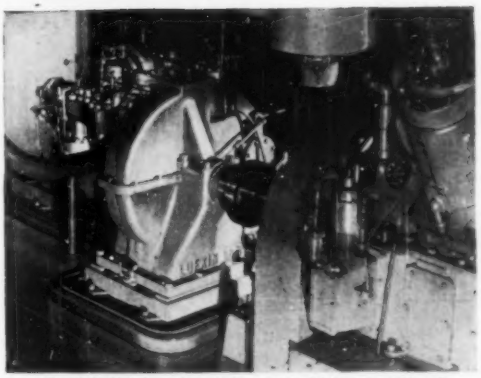

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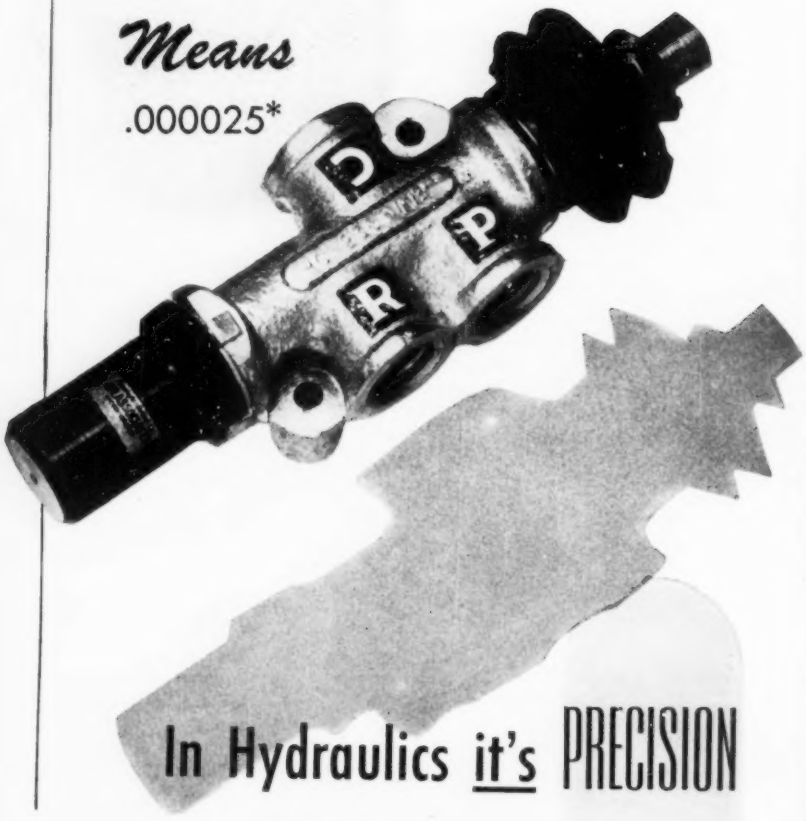

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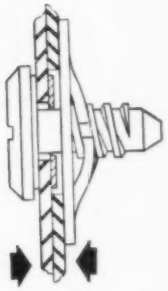

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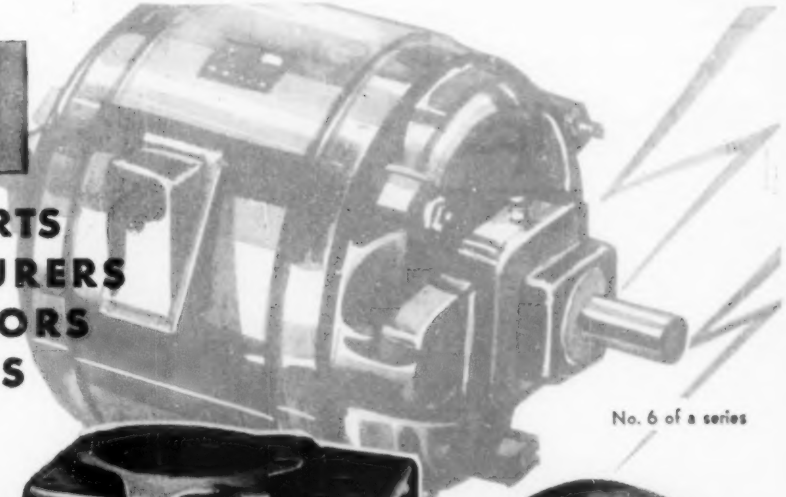

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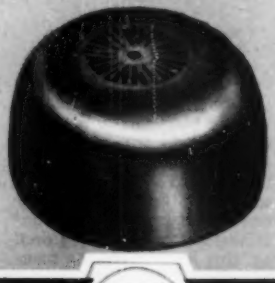

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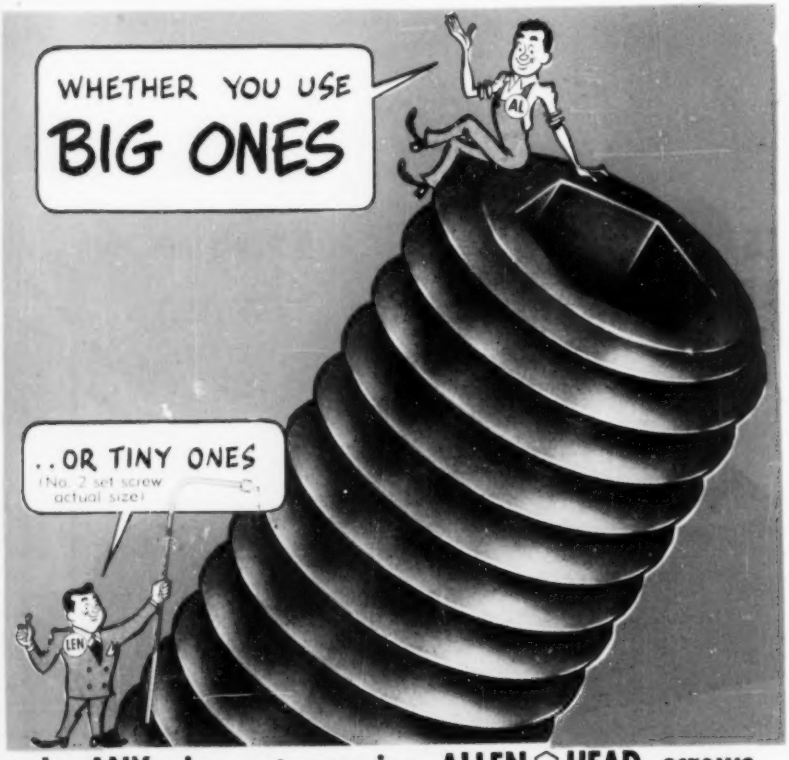

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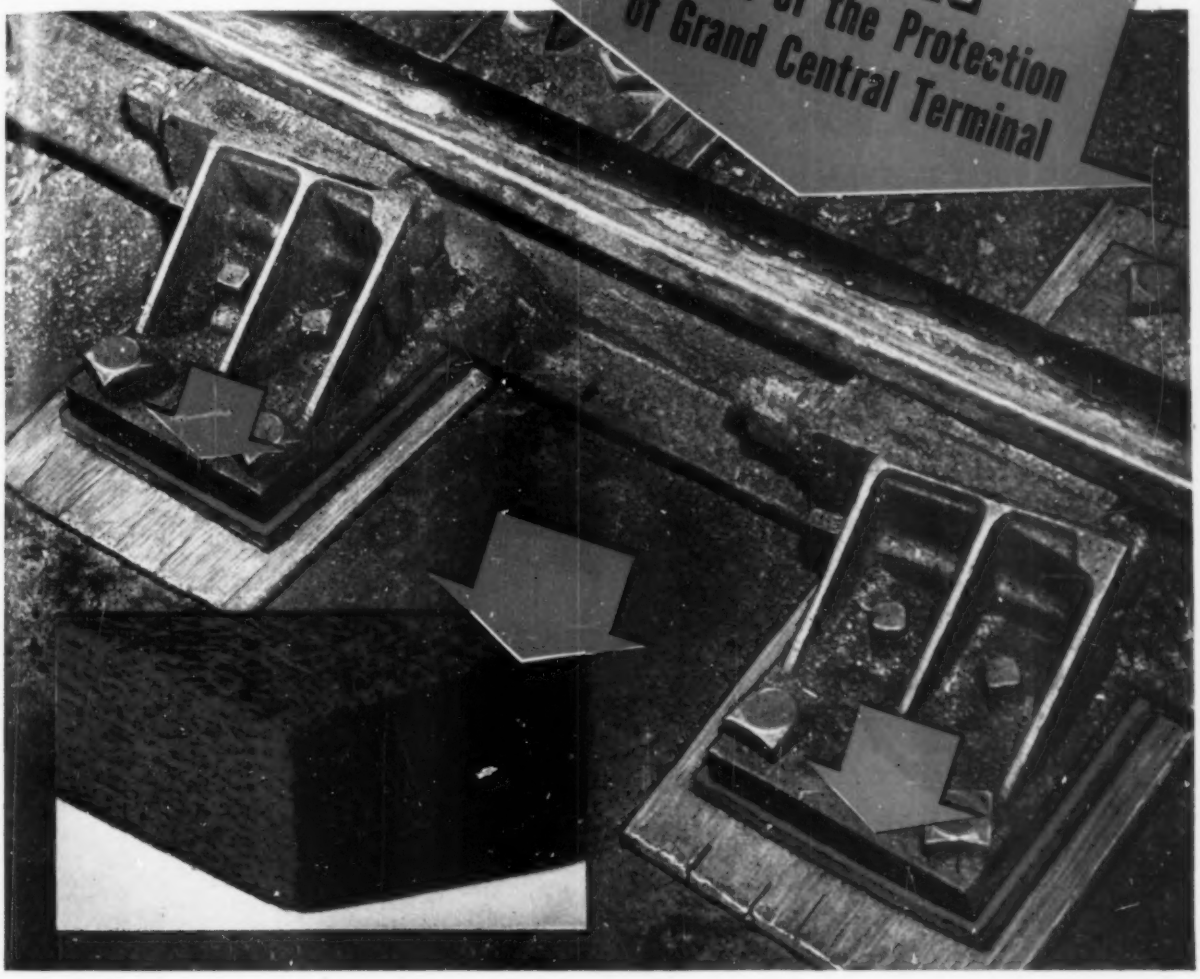

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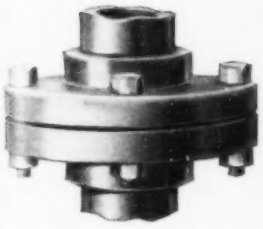

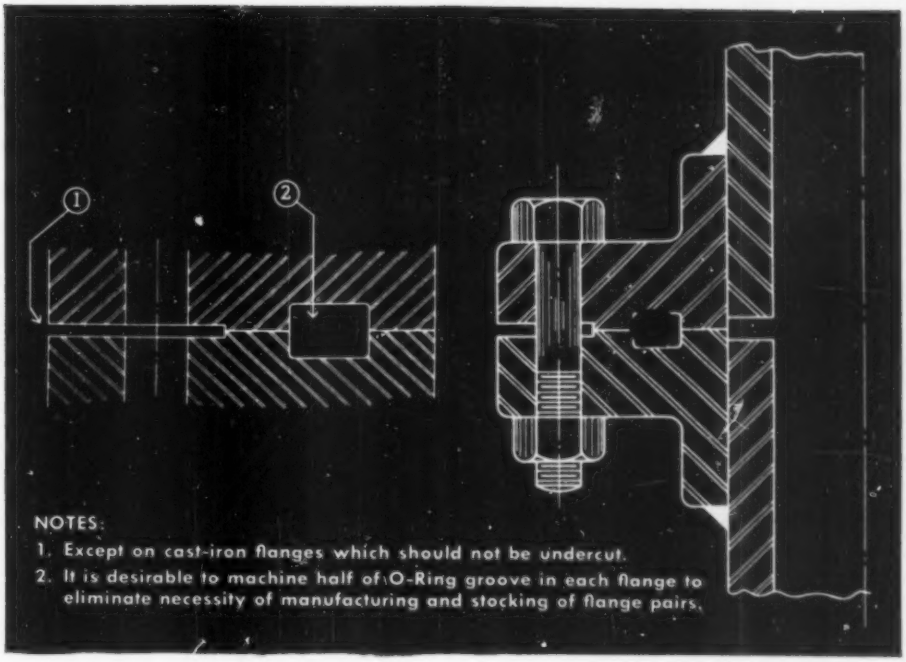
1
2
NOTES:
1. Except on cast-iron flanges which should not be undercut.
2. It is desirable to machine half of O-Ring groove in each flange to eliminate necessity of manufacturing and stocking of flange pairs.

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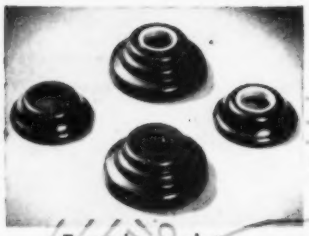

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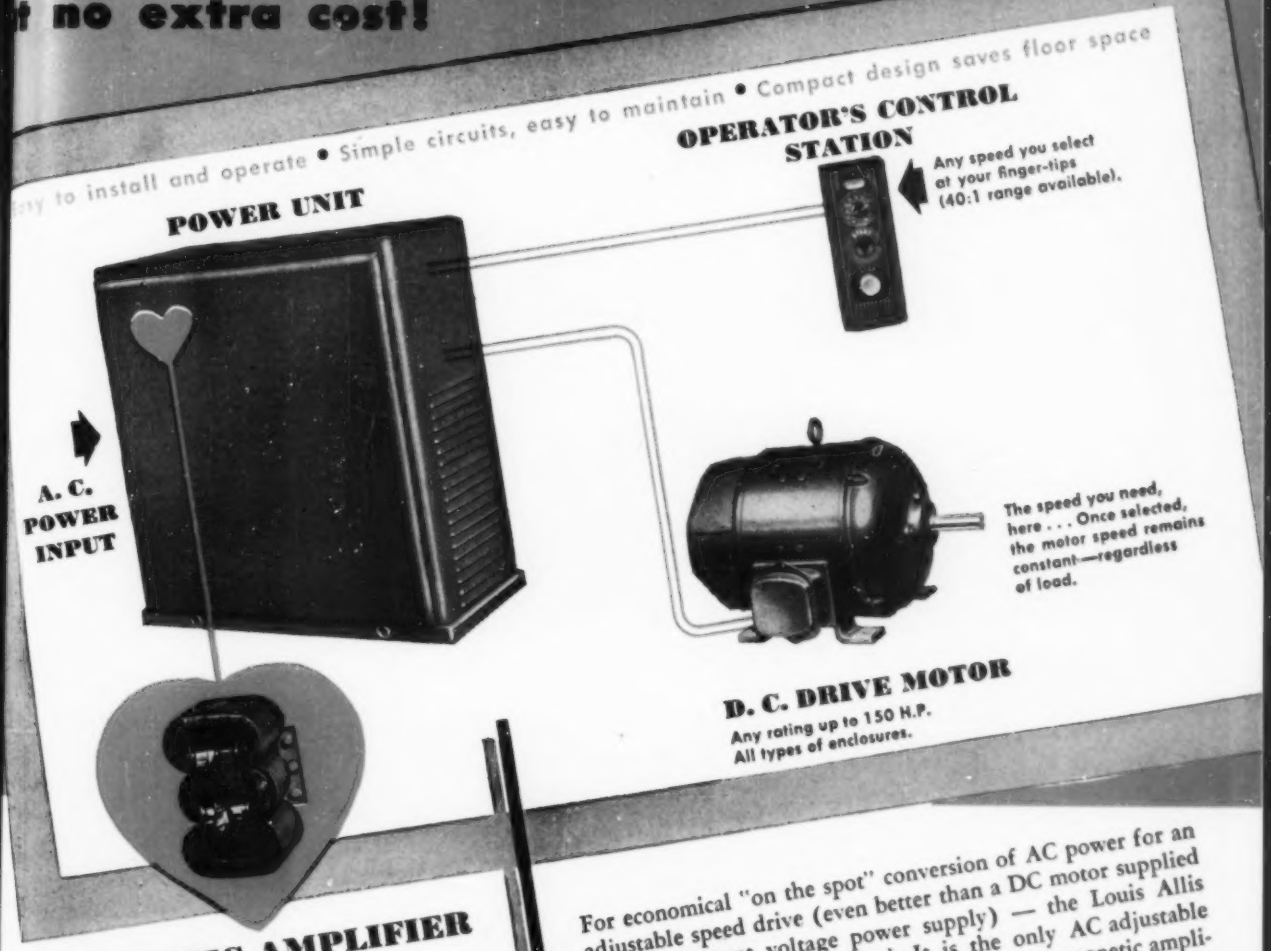
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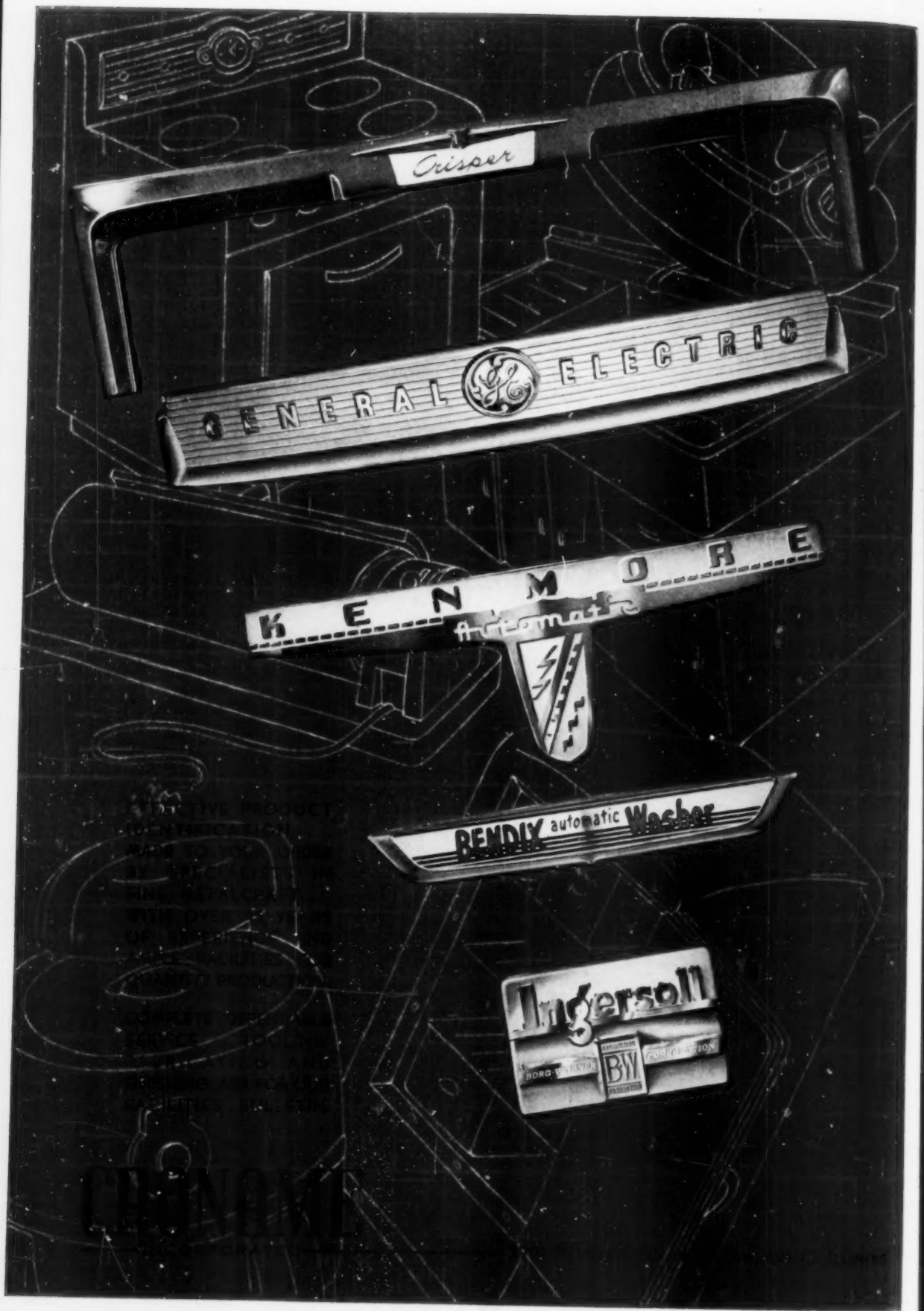
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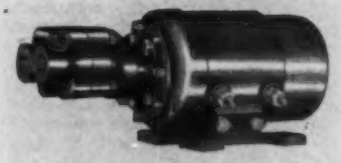

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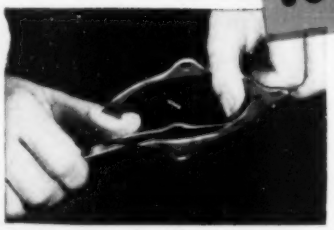

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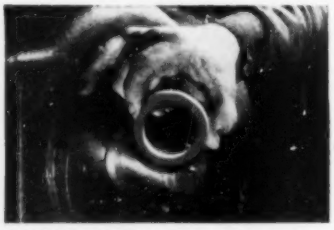

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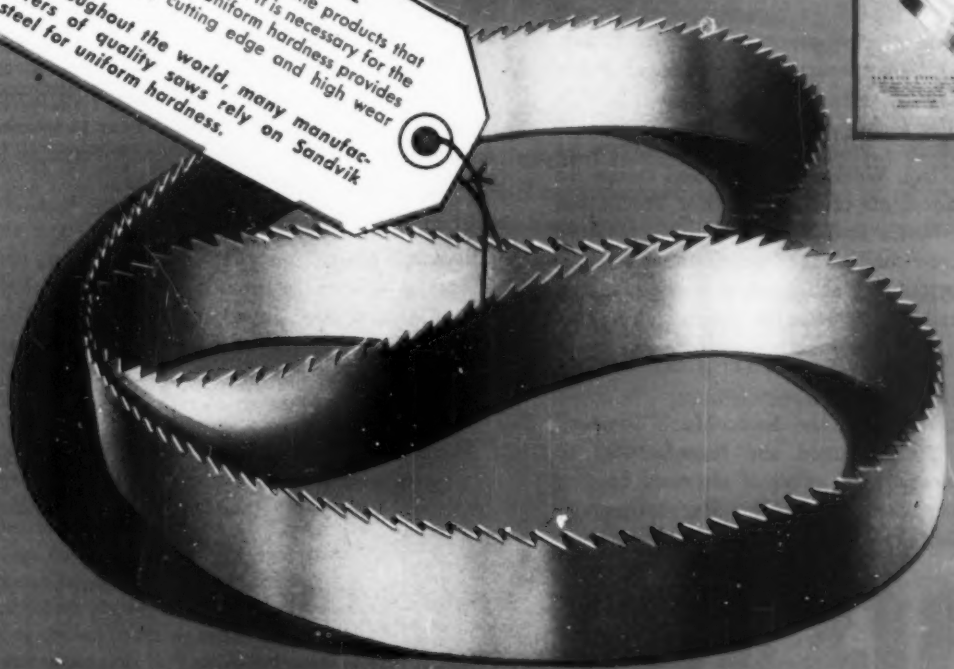
A high quality saw is one of the products that require uniform hardness. It is necessary for the setting of the teeth. Uniform hardness provides a keen, lasting cutting edge and high wear resistance.

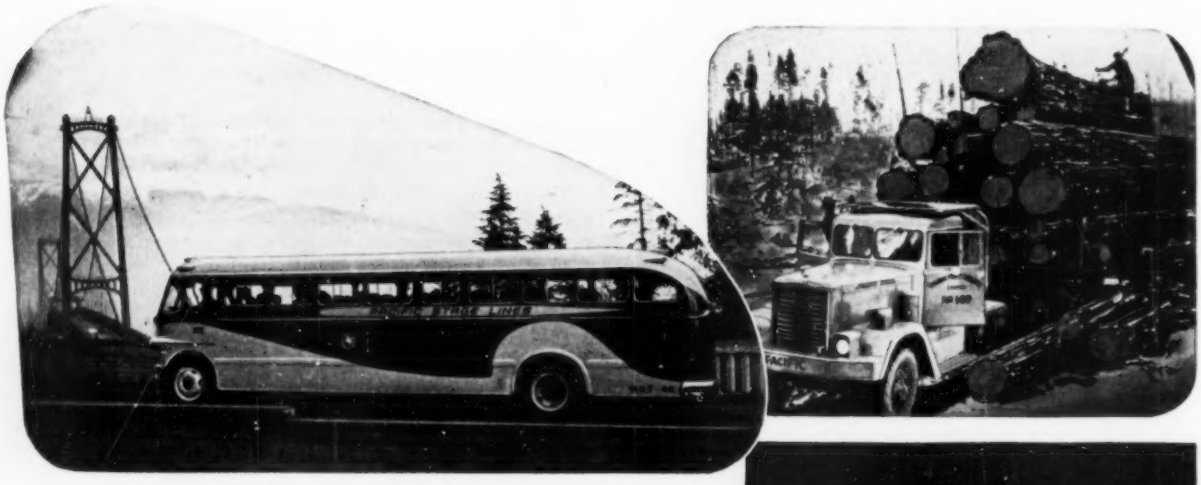
Throughout the world, many manufacturers of quality saws rely on Sandvik steel for uniform hardness.



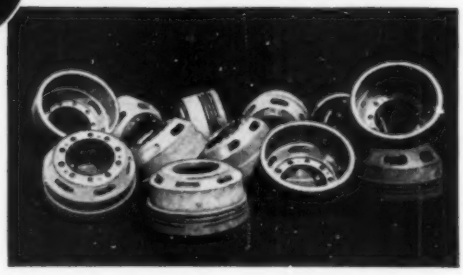
SOME SANDVIK SPECIALTY STRIP STEELS—Steel for Textile Machine Parts • Band Saw Steels; Metal Band, Wood Band and Butcher Band • Camera Shutter Steel • Clock and Watch Spring Steels • Compressor Valve Steel • Doctor Blade Steel • Feeler Gauge Steel Knife Steels • Razor Blade Steel • Reed Steels • Shock Absorber Steel • Sinker Steel Spring Steels • Trowel Steel • Vibrator Reed Steel, etc.

Sandvik Quality Steels

Research Develops a Solid Foundation



Pictured above are two users of Sorbo-Mat "Sumner" Brake Drums, a Pacific Stage Lines Bus and a loaded Logging Truck of the Pacific Truck and Trailer Co. (Canadian Forest Products Ltd.). Also shown are a group of Brake Drums used on British Columbia Electric Trolley Coaches and Pacific Stage Lines Busses.



Heavy-Duty Brake Drums with longer service-life, improved performance plus added safety!

Heavy transports, loaded to capacity, often require positive braking action upon a moments notice. Today, more dependable, longer-wearing and stronger brake drums are available for extra safety.

Sorbo-Mat "Sumner" Brake Drums, manufactured by Canadian Sumner Iron Works, have met and conquered the rigorous requirements of Busses, Motor Trucks and Trailers, Trolley Busses and Motor Coaches operating under the most severe conditions of mountainous Western Canada. This outstanding achievement is the result of cooperative metallurgical research with Sorbo-Mat Process Engineers to increase the performance and life of these castings.

The matrix structure of the Sorbo-Mat "Sumner" Drum iron was predetermined and manufactured to better resist the detrimental effect of alternate heating and cooling, that is, thermal checking or crazing, under sudden or gradual brake actions. This is the most prevalent cause of drum failure. The severest type of this failure is found in the Logging Industry where drums on trucks and trailers are water-cooled while descending steep grades. Cutting off water too soon permits the latent heat stored in linings and shoes to overheat the drums causing extreme crazing. Sudden cooling of overheated drums likewise causes crazing.

Sorbo-Mat "Sumner" Brake Drums have shown a remarkable resistance to wear in actual usage, remaining in service without maintenance after more than twice the mileage secured from previous drums. This drum iron possesses splendid breathing properties enabling it to resist thermal checking and, in addition, combines maximum strength and machinability.

The performance of Sorbo-Mat "Sumner" Brake Drums has established a new yardstick for measuring brake drum life with safety plus operating and maintenance economies.

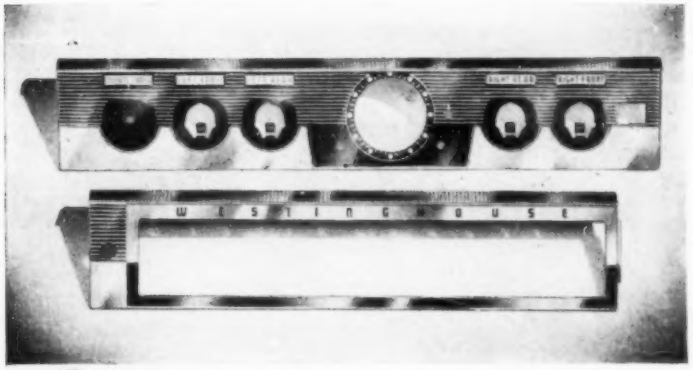
Sorbo-Mat Process Engineers . St. Louis, Mo., U.S.A.

CONTROLLED SPECIFICATION CAST IRONS — STRUCTURE STRENGTH SERVICE — SORBO-MAT

Acme Foundry & Machine Co.	Blackwell, Oklahoma	General Metals Corporation	Oakland, California
Acme Foundry & Machine Co.	Coffeyville, Kansas	Gra-Iron Foundry Corporation	Marshalltown, Iowa
Canadian Sumner Iron Works Ltd.	Vancouver, British Columbia	Marion Machine, Foundry & Supply Co.	Marion, Indiana
Commercial Iron Works	Los Angeles, California	Overmyer Mould Company	Winchester, Indiana
Darling Valve & Mfg. Company	Williamsport, Pennsylvania	Sorbo-Cast Corporation	New Brunswick, New Jersey
Dayton Foundry	Hollydale, California	The Murray Company of Texas, Inc.	Dallas, Texas
J. B. Ehrsam & Sons Mfg. Co.	Enterprise, Kansas	Viking Pump Company	Cedar Falls, Iowa

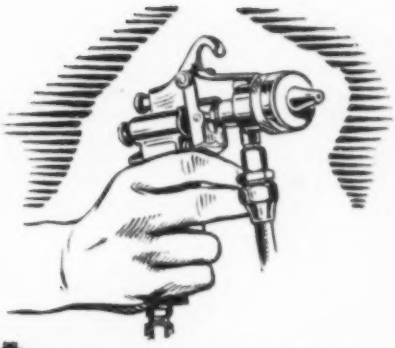
"This advertisement sponsored by the above licensees"

BETTER CASTINGS THROUGH IMPROVED FOUNDRY TECHNIQUES



$ DESIGN FOR LOW COST LETTERING

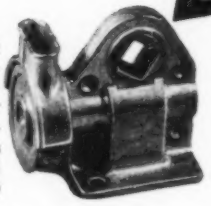
The lettering on the two ZINC Die Cast electric range panels above was designed with a watchful eye on cost. Raised, not recessed, lettering on the top panel lowers die cost, since it is easier to cut a design into the die than to make a raised design on the die surface. The lettering on the bottom panel is pierced after casting. If these letters were cored in the casting operation, some flash would be left at each opening. It is just as easy to pierce the lettering through the uncored wall as to shear the flash.



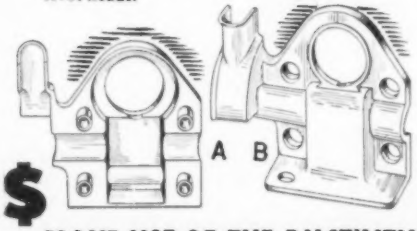
$ PRETREAT—THEN PAINT

While any type of plated or organic coating can be applied on ZINC Die Castings, remember that it is false economy not to apply a suitable chemical pretreatment before painting. Pretreatment assures good adherence and, thus, complete customer satisfaction.

How to get the mo$t fo[illegible]ur Zinc Die Ca$ting D[illegible]r!



Assembly of this venetian blind operator is completed by inserting the four cast studs on die casting (A) in cored holes in casting (B) and spinning over the rivet heads.



$ MAKE USE OF THE DUCTILITY

Cast studs or rivets provide an economical means of fastening ZINC Die Castings to mating parts. Speed fasteners can be used on such projections or, as shown above, the rivets can be spun or staked to act as self-fasteners. The latter practice is feasible because of the high ductility of ZINC Alloys.

While ZINC Die Castings are inherently low in cost, parts should be designed *specifically* for this metal and method of production if maximum economy is to be achieved. The few hints given here may help you to get more for your die casting dollar.

We suggest, however, that you ask us—or your die caster—for a copy of "Designing For Die Casting". This booklet will give you a better working knowledge of the full economic possibilities of ZINC Die Castings.

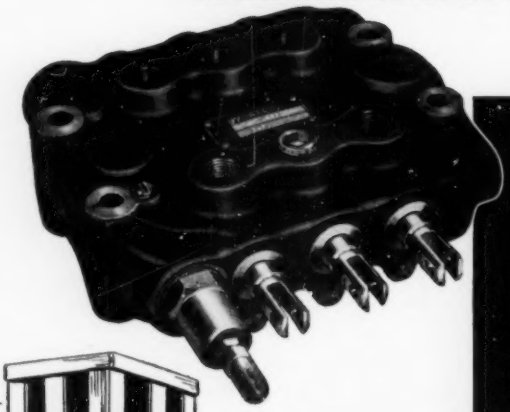
The New Jersey Zinc Company
160 Front St., New York 7, N. Y.

ZINC
FOR DIE CASTING ALLOYS

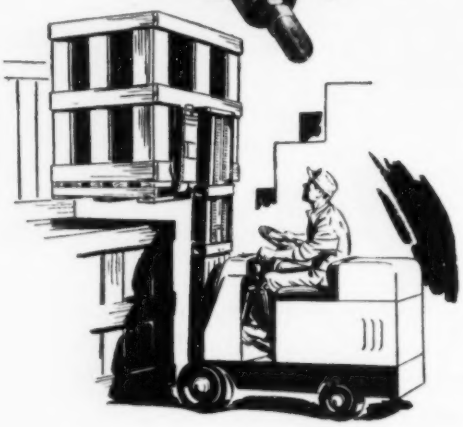
The Research was done, the Alloys were developed, and most Die Castings are based on
HORSE HEAD SPECIAL (99.99 + % Uniform Quality) ZINC

DO YOU USE Oil Hydraulics?

80% of all leading industrial lift truck manufacturers use...



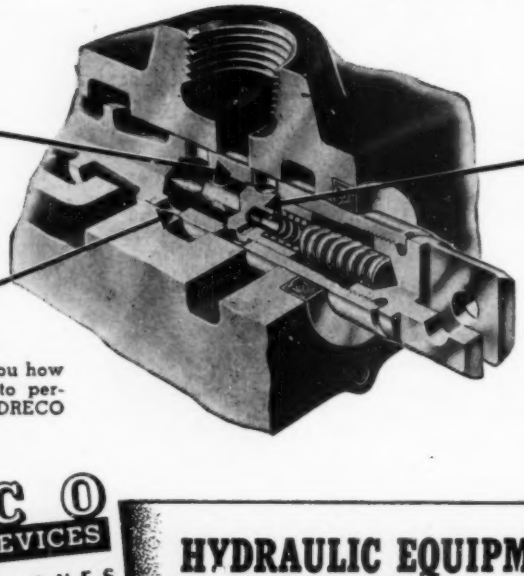
HYDRECO
HOLLOW-PLUNGER* VALVES



HYDRECO EQUIPPED TRUCKS CUT OPERATING COSTS FOR THEIR OWNERS.

— for smooth and accurate control of raising, tilting and accessory operations.

HYDRECO Hollow-Plunger control valves build in the fast and safe control so necessary to proper lift truck operation. Accurate throttling characteristics, inherent in HYDRECO valves, cut out lost motion in picking up and stacking. Built-in check valves of the Hollow-Plunger design entirely eliminate momentary load drops and jerky operations. There are no dead spots in HYDRECO valve operation to create pressure peaks, damaging to the hydraulic system.



Patented hollow plunger with no dead spots to create pressure peaks.

Circular ports are staggered in the plunger for accurate throttling.

Check valve assembly prevents pressure drop in the cylinder while pressure port is opening.

*Hollow-Plunger protected by existing U. S. and Foreign Patents as well as patents applied for.

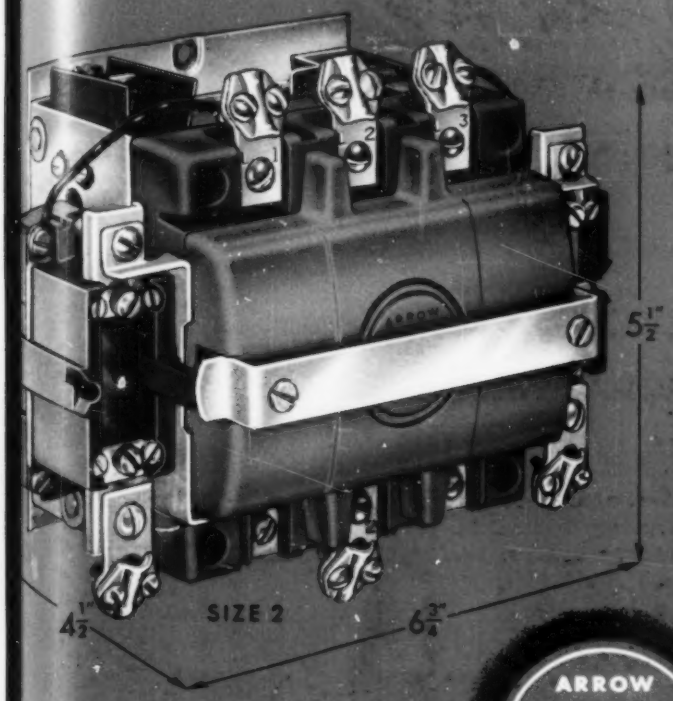
Let HYDRECO engineers show you how your equipment can be made to perform faster and safer with HYDRECO Hollow-Plunger control valves.

WRITE TO —

HYDRECO
HYDRAULIC CONTROL DEVICES
PUMPS · CYLINDERS · VALVES

HYDRAULIC EQUIPMENT COMPANY
111½ EAST 222nd STREET • CLEVELAND 17, OHIO

BRING OUT **BUILT-IN PERFORMANCE** OF MOTORS AND MACHINERY

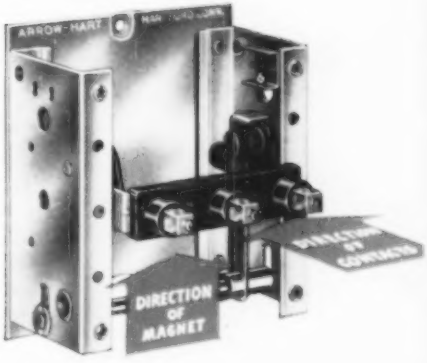


Arrow-Hart "RA" Magnetics teamed with "PPS" Switch provide fully automatic control for Steinle thread generating machine.

NEW TYPE "RA" ARROW AH HART MAGNETIC STARTERS

JUST 1/2 THE SPACE

PLUS EXCLUSIVE NEW "RA" BALANCED MECHANISM



POSITIVE ACTION — SUPERIOR CONTACT ALIGNMENT

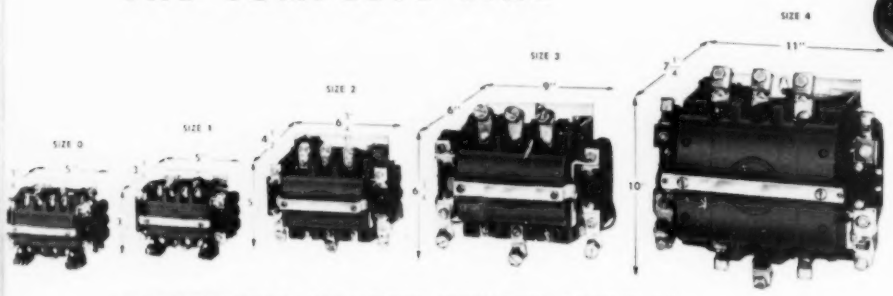
To get the best from your equipment — to bring out its built-in performance, specify Arrow-Hart Magnetic Starters. These new starters, available in sizes 0-1-2-3-4, feature the amazing new "RA" Right Angle Balanced mechanism, exclusive with Arrow-Hart. This mechanism has a knee-action bellcrank fulcrum, which transfers the leverage from a vertical to a horizontal plane, multiplying leverage and increasing contact pressure. Superior contact alignment is achieved through GUIDED parallel closure of contacts. The revolutionary design of the "RA" cuts conventional starter size in half, giving you a new freedom in engineering, new compactness. The extra safe, extra dependable "RA" has new, larger contacts, improved magnet and coil. And it's easy to wire and service. These are only a few of the many features that add up to outstanding performance in Arrow-Hart "RA" Magnetic Starters — features that "bring out built-in performance."

BUY WITH CONFIDENCE *PROFIT BY PERFORMANCE*

THE ARROW-HART & HEGEMAN ELECTRIC COMPANY, HARTFORD, CONN., U. S. A.

ARROW AH HART

MAKE YOUR SELECTION FROM THE COMPLETE LINE



ARROW-HART TYPE "RA" MAGNETIC STARTERS

For original equipment designers and manufacturers the Arrow-Hart line of "RA" Magnetic Starters means an overall reduction in the size of the control panel, smaller control equipment cavities, lower material costs. For installation and maintenance men it means a job done easily, quickly, at lower cost. A space-saver, a time-saver, a work-saver, it's the most versatile line on the market, in application and in performance. Investigate it. Specify it. Buy it.

PUSH-PULL-SELECTOR SWITCH

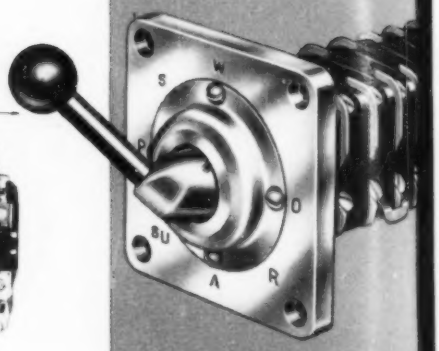
Provides a single point of control for a multiple-operation machine. Any combination of momentary contact elements can be arranged. Up to 16 dial positions. Stop or start in any position — move to any point without activating intervening points.

2-SPEED AND REVERSING CONTACTOR

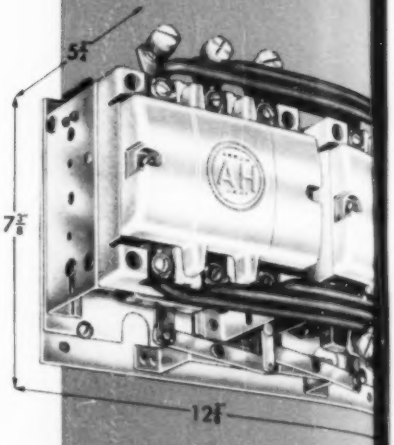
Provides full protection to operator, machine and work. Same features as A-H Magnetic Starters described on these pages. Positive mechanical interlock. Reverse contacts do not start to close until forward contacts are completely open. Switches are coupled by roller-type, free-floating linkage. Free-release transfer action.

DESCRIPTIVE LITERATURE ON REQUEST

Write today for literature and required engineering data on Arrow-Hart type "RA" Magnetic Starters and Contactors. Available in local and remote control or selector switch types in sizes 0-1-2-3-4. There is an Arrow-Hart field engineer in your territory to assist you with your industrial motor control requirements. Consult your local electrical distributor or write the factory for engineering service.



PUSH-PULL SELECTOR SWITCH



SIZE 2 REVERSING CONTACT

ENGINEERING DATA FOLDERS

ARROW·HART

THE ARROW-HART & HEGEMAN ELECTRIC COMPANY
103 HAWTHORN STREET
HARTFORD 6, CONNECTICUT, U. S. A.

Branches in: BOSTON, CHICAGO, CLEVELAND, CINCINNATI, DALLAS, DENVER, DETROIT, LOS ANGELES, NEW YORK, PHILADELPHIA, SAN FRANCISCO, SYRACUSE. In Canada: ARROW-HART & HEGEMAN (CANADA) LTD., MT. DENNIS, TORONTO

IMPROVE PRODUCTS...REDUCE COSTS WITH CONTINUOUS-CAST BRONZES

The properties of ASARCO *continuous*-cast alloys improve the performance of your product . . . add to its acceptance . . . sale . . . reputation.

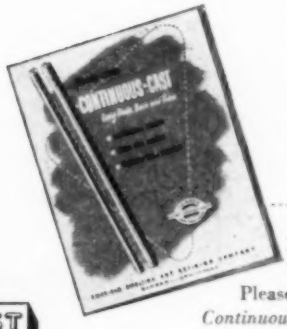
The ASARCO process for continuous casting makes available a wide range of alloys in a form equivalent, in all essential respects, to long mill rods, tubes and shapes. Previously these same alloys have been available only as sand, permanent-mold, or centrifugal castings. *Continuous*-cast copper base alloys are exceptionally uniform and free from porosity . . . hard and soft spots are eliminated. The metallurgical quality of *continuous*-cast bronze is so high that part after part passes the most rigid inspection.

This new form of continuous casting offers another tool for much greater economies in production. With ASARCO *continuous*-cast bronze your products can be made on automatic screw machines, presenting an opportunity for high production rates at low cost.

Because of the unique characteristics of the ASARCO *continuous*-cast process, the exclusion of impurities, porosity, and the even dispersion of alloy constituents, fatigue characteristics are raised 33% to 100% . . . impact strengths increased from 15% to more than double that of the same alloys produced by other casting methods . . . tensile strength, yield strength, and hardness substantially improved.

By specifying ASARCO *continuous*-cast, copper alloy rods, tubes or shapes, you get stock cut precisely to your requirements in lengths ranging from 5′ to 20′. Rods and tubes for gears, shafts, and other machine parts . . . tubes for sleeves, bushings, bearings, or liners . . . 215 standard sizes in lengths of 105″ are stocked for exacting production requirements . . . shapes, bars, or tubes with ridges or splines made to order.

ASARCO's technical representatives can show you how to improve your products and reduce your costs by using *continuous*-cast bronze.



Send for ASARCO Continuous-*Cast Booklet, you'll find useful application and specification data on "*ASARCO Continuous-*Cast Copper Alloys," . . . development of* ASARCO *process . . . values of* ASARCO *process . . . typical physical properties chart . . . impact chart . . . photo-micrographs . . . fatigue graph . . . table of standard* ASARCON *alloys and size limitations . . . shapes available . . . tube weights . . . table of stock sizes and weights.*

ASARCO CONTINUOUS-CAST RODS · TUBES · SHAPES

West Coast Sales Agent:
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American Smelting and Refining Company
Perth Amboy Plant, Barber, New Jersey

American Smelting and Refining Company
Perth Amboy Plant, Barber, New Jersey

Please send me a free copy of the new 12-page booklet "ASARCO *Continuous*-Cast Copper Alloys."

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for hauling CEMENT or designers rely on MORSE

Furnishing candy for the nation's sweet tooth and handling heavy materials like cement are activities that call for machines that are entirely different. But designers of equipment for both types of jobs have chosen Morse Power Transmission Products for performance and dependability. In its Moto-Bug power wheelbarrow, the Kwik-Mix Company uses a Morse-Rockford Double Pullmore Clutch and a Morse Roller Chain Drive to the front wheels. The Currie Manufacturing Company uses three sizes and dozens of feet of Morse Roller Chain in its labor-saving, automatic starch tray stackers and feeders for candy makers.

Morse—Unlimited in Applications

Whatever your mechanical power transmission needs—for clutches, for precision-made roller or silent chain or sprockets, for couplings or drive shafts—Morse can fill them. Morse engineers' wide experience in solving power transmission problems for almost every industry, and Morse's long record of producing a great variety of the finest mechanical power transmission equipment are your assurance that M=PT, Morse *means* Power Transmission.

M=PT

BASIC FORMULA

Morse *means* Power Transmission

For more complete information about Morse Roller Chains and Sprockets, write today and ask for Catalog C51-50. For the full clutch story, ask for Pullmore Clutch catalog.

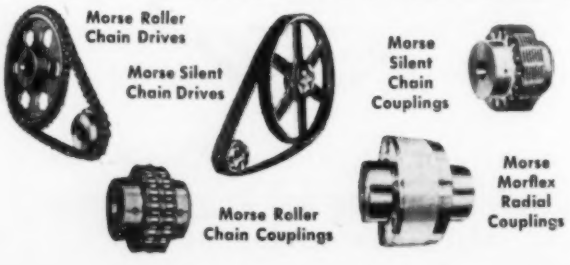
Ask the Morse Man for power transmission information!

MORSE CHAIN COMPANY

Dept. 594, 7601 Central Avenue, Detroit 8, Michigan

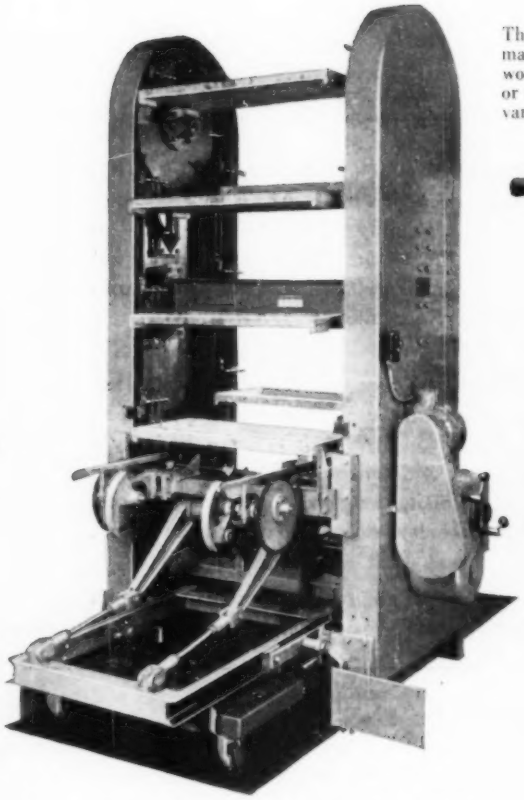
100 Morse Branch Offices and Distributors to supply your power transmission demands.

From coast to coast there are more than 100 offices, representatives and distributors of Morse Power Transmission products to give you quick information and service when you want it—where you want it. *Ask the Morse Man first in any case!* Check your classified phone directory under **"Power Transmission"** or **"Chains"** for the nearest Morse Man.


Morse Roller Chain Drives
Morse Silent Chain Drives
Morse Silent Chain Couplings
Morse Roller Chain Couplings
Morse Morflex Radial Couplings

making CANDY...

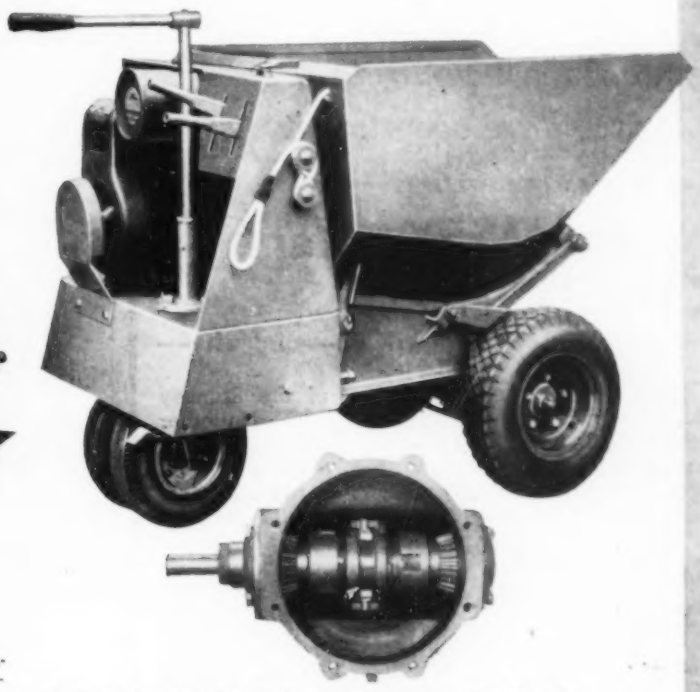
POWER TRANSMISSION PRODUCTS



Currie automatic starch tray stackers and feeders increase production, reduce tray breakage for candy manufacturers. Since their development about ten years ago, these machines have been equipped with Morse Roller Chain.

Morse Roller Chain provides positive power transmission without slippage, saves space, allows design freedom. Morse Roller Chain is precision-built for long, trouble-free service under a wide variety of working conditions. It uses teeth, not tension; gives 99% efficiency.

The Kwik-Mix Moto-Bug takes the hard work and high cost out of materials handling, the pulling and pushing out of wheelbarrow work. With a capacity of 1200 pounds or ten cubic feet in its hopper or on its interchangeable platform, the Moto-Bug handles a wide variety of materials.



Double Morse-Rockford Pullmore Clutch on versatile Moto-Bug is used on main drive. It provides forward or reverse motion at full power. Particularly compact, powerful, smooth-running, the clutch has proved its efficiency, economy, and reliability in rugged service. Morse-Rockford Pullmore Clutches are made in single and double types, for dry operation or operation in oil in many capacities ranging from one to ninety horsepower at 500 r.p.m.

Morse Morflex Couplings

Morse-Rockford Clutches

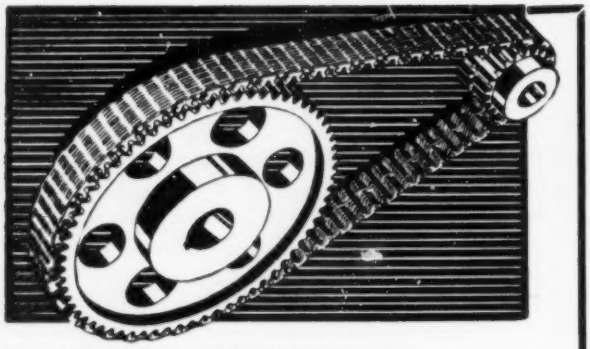
Morse Morflex Drive Shafts

Morse-Rockford Pullmore Clutches

MORSE

MECHANICAL
POWER TRANSMISSION
PRODUCTS

PRODUCTS OF B-W BORG-WARNER



So You're DESIGNING a NEW MACHINE

well don't forget
that its efficiency
is no better than
the drive operating it

Let us show you what a

RAMSEY *Silent* CHAIN DRIVE

will do—and why—

Look at the illustration below of the Ramsey Roller Bearing Joint. IT'S DIFFERENT. No other make of silent chain is like it. A Ramsey Chain with this joint in every link, will operate at high speeds without heating and with no more lubrication than required by an ordinary roller bearing.

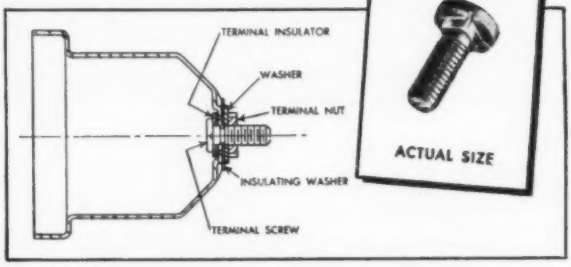
See how it ROLLS . . .

Designed on the principle of a roller bearing. Surfaces of the pins are convex to permit a rolling action with absolutely no friction. See how the open construction allows oil to penetrate and adhere to the working surfaces.

SEND FOR A COPY of the 60-page fully illustrated Ramsey Engineering Manual No. 650. It will show you how easily you can improve your product by improving the drive.

RAMSEY CHAIN CO., INC.
5051 BROADWAY • ALBANY, N. Y.

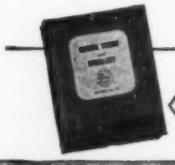
TERMINAL USED AS A NOSE!



KING-SEELEY CORPORATION designed this Progressive-made terminal to permit the housing of its oil pressure unit to "breathe" — a feature that insures the presence of atmospheric conditions inside the housing and, consequently, accurate pressure registration.

Progressive was called in to make the terminal for two reasons. We have the engineering and production skills to make the part, in all its tricky detail, according to specification. And, secondly, we do a precise job at a cost that makes it worthwhile to do business with us.

We specialize in special fasteners. Use this specialization — you gain all ways.



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IT MAY SAVE YOU MONEY

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QUALITY PROMCO BRAND

THE PROGRESSIVE MANUFACTURING COMPANY
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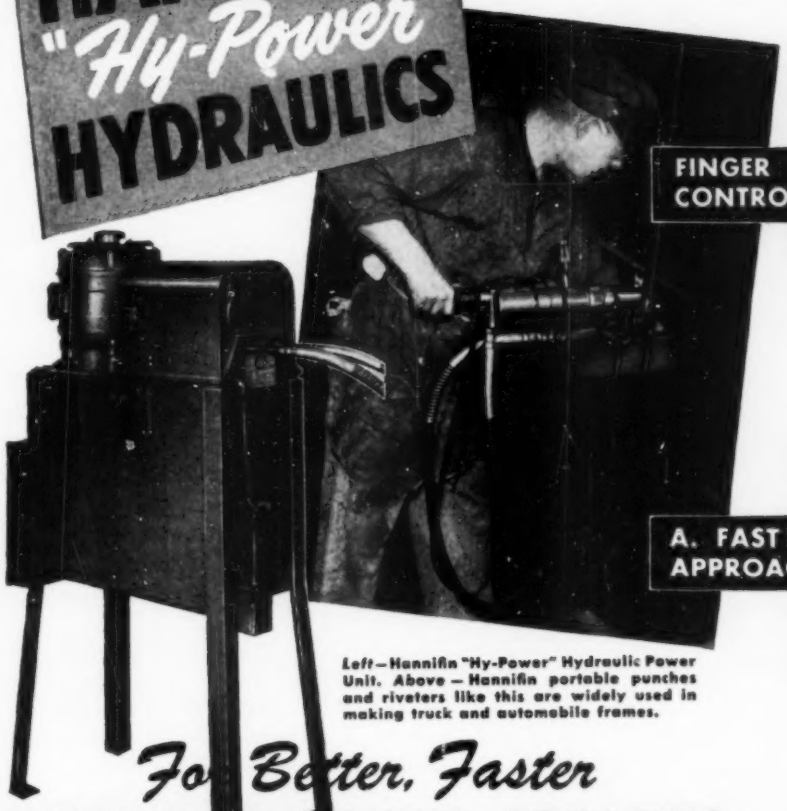
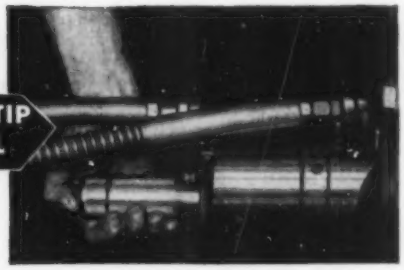
SALES OFFICES: SAN FRANCISCO, LOS ANGELES, PORTLAND, DETROIT, PHILADELPHIA, CLEVELAND, SEATTLE, BOSTON, SYRACUSE, ST. LOUIS, CHICAGO.

HANNIFIN "Hy-Power" HYDRAULICS

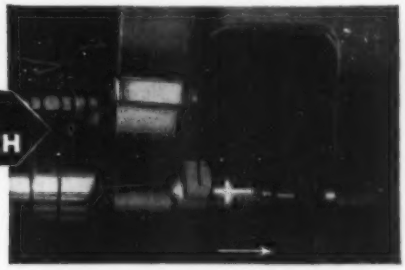
...the pictures TELL THE STORY!



Left—Hannifin "Hy-Power" Hydraulic Power Unit. Above—Hannifin portable punches and riveters like this are widely used in making truck and automobile frames.



Push button under operator's thumb provides complete control. Pictures illustrate riveting cycle.



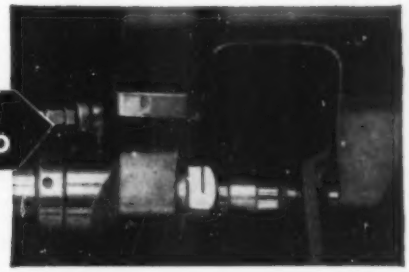
Pressing button moves ram up to work at fast speed using primary hydraulic pressure.

For Better, Faster RIVETING, PUNCHING, PRESSING

HANNIFIN Portable Yoke Riveters are built in more than 40 different standard sizes with capacities ranging from 7½ to 100 tons. A similar wide choice is offered in punches, presses, and multiple punching and multiple riveting equipment.

The Hannifin "Hy-Power" Hydraulic Power Unit is the heart of the "Hy-Power" System. Up to 5,000 p.s.i. pressure at your finger-tip under exclusive automatic control. Although it occupies less than 6 sq. ft. of floor space, it is capable of delivering hundreds of tons of useful force.

Hannifin furnishes everything you need to make "HY-POWER" HYDRAULICS work efficiently and dependably in your shop or plant: power units, controls, and portable or stationary work units. Today in thousands of installations throughout the world, production engineers and tool designers are using "HY-POWER" HYDRAULICS as the key to better, faster production and lower costs for an almost unlimited range of applications! You, too, can benefit from this equipment. *For complete information, see your local Hannifin representative, or write.*



Hydraulic pressure is automatically intensified and the rivet is completely formed.

At peak hydraulic pressure (adjustable), the ram reverses automatically and returns to starting position. Total elapsed time approximately 2½ seconds for ⅜" cold rivet.

HANNIFIN CORPORATION

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2 to 4 Pole 2-3/4″ w. x 3-5/8″ h. x 3-5/16″ d.
5 to 8 Pole 5-9/16″ w. x 3-5/8″ h. x 3-5/16″ d.

Reversing

2 to 4 Pole 5-9/16″ w. x 3-5/8″ h. x 3-5/16″ d.

Note: 10 and 15 ampere contactors have same mounting and overall dimensions.

✓ **ACCESSIBILITY**

To replace contacts, it is not necessary to disassemble the complete contactor. Just remove the parts comprising the stationary and movable contacts. Contacts can be replaced without disturbing wiring. To change coil, remove magnet frame and coil assembly only. (See illustration below.)

✓ **FLEXIBILITY**

Using a screw driver only, you can easily change any pole from normally open to normally closed. No special parts required. 10 and 15 ampere parts are interchangeable.

✓ **RELIABILITY**

Laboratory tests involving millions of operations, plus field service of thousands of R-B-M contactors on door operators, radio transmitters, packaging and weighing machinery, hoists, machine tools and many other industrial applications offer proof of dependable, trouble-free performance.

✓ **ADVANCED DESIGN**

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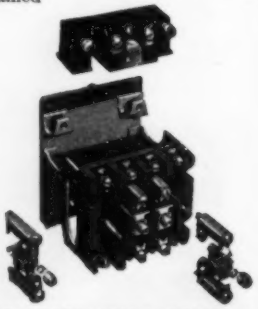

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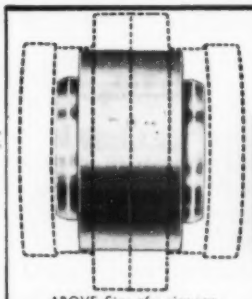

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1/2 usual weight!

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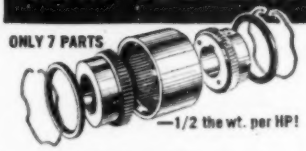
ONLY 7 PARTS



—1/2 the wt. per HP!

ABOVE: Size of major conventional types (averaged in outline) compared with Sier-Bath Gear Coupling of same shaft size.

- ***Slashes time and labor costs***—only 7 parts! Assembled, uncoupled in seconds—no special tools, easy to align.
- ***Saves design space, weight***—averages only 3/5 the size, ½ the weight of conventional gear couplings of same shaft size.
- ***Cuts original costs***—prices lower than conventional gear couplings.
- ***Needs less shaft space for assembly,*** uncoupling—still fits existing designs, easily replaces old style couplings.
- ***Reduces wear on coupled equipment*** — less weight, smaller size reduces strain on shafts and bearings.
- ***Decreases accidents***—no bolts, nuts, protruding parts—safe as a smooth shaft.

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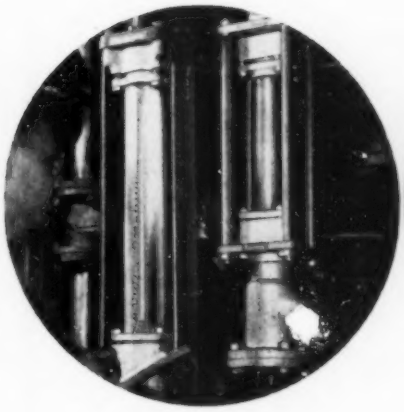
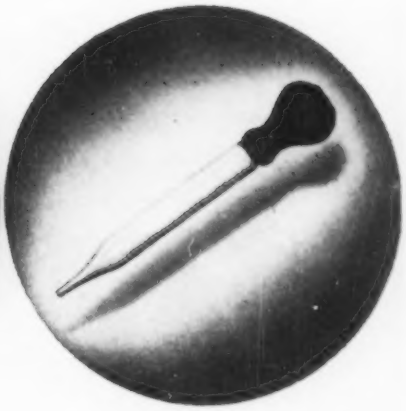
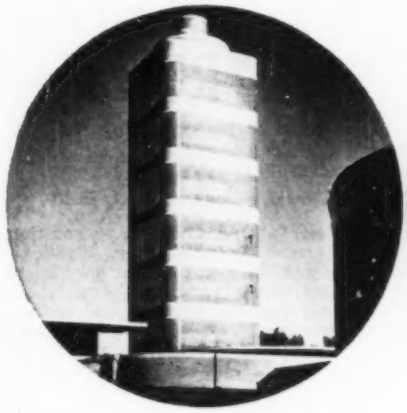


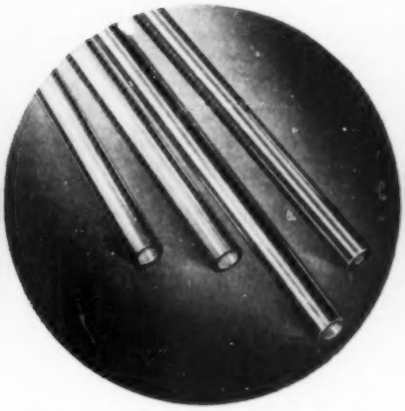
Rate of flow of liquids checked with Rotometers.



Baster tubes help the housewife handle hot liquids.



PYREX brand pipe used as a structural material for new Johnson Wax Building.



Steam under high pressures requires tough corrosion resistance of PYREX brand gauge glasses.

Colored tubing for Neon signs possesses high dielectric strength.

Have You Ever Considered Glass Tubing?

As you can see, some imaginative engineers have used glass tubing by Corning to solve quite a range of problems. Supplied by Corning in a wide variety of characteristics and dimensions, it lends itself to countless applications. Available now and not too costly, it is worth a good look.

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For electrical applications, Corning can give you glass tubing that is high in dielectric strength and that seals to metal. Tubing can also be had in various colors. Where precision is required, Corning can supply tubing to extremely close tolerances.

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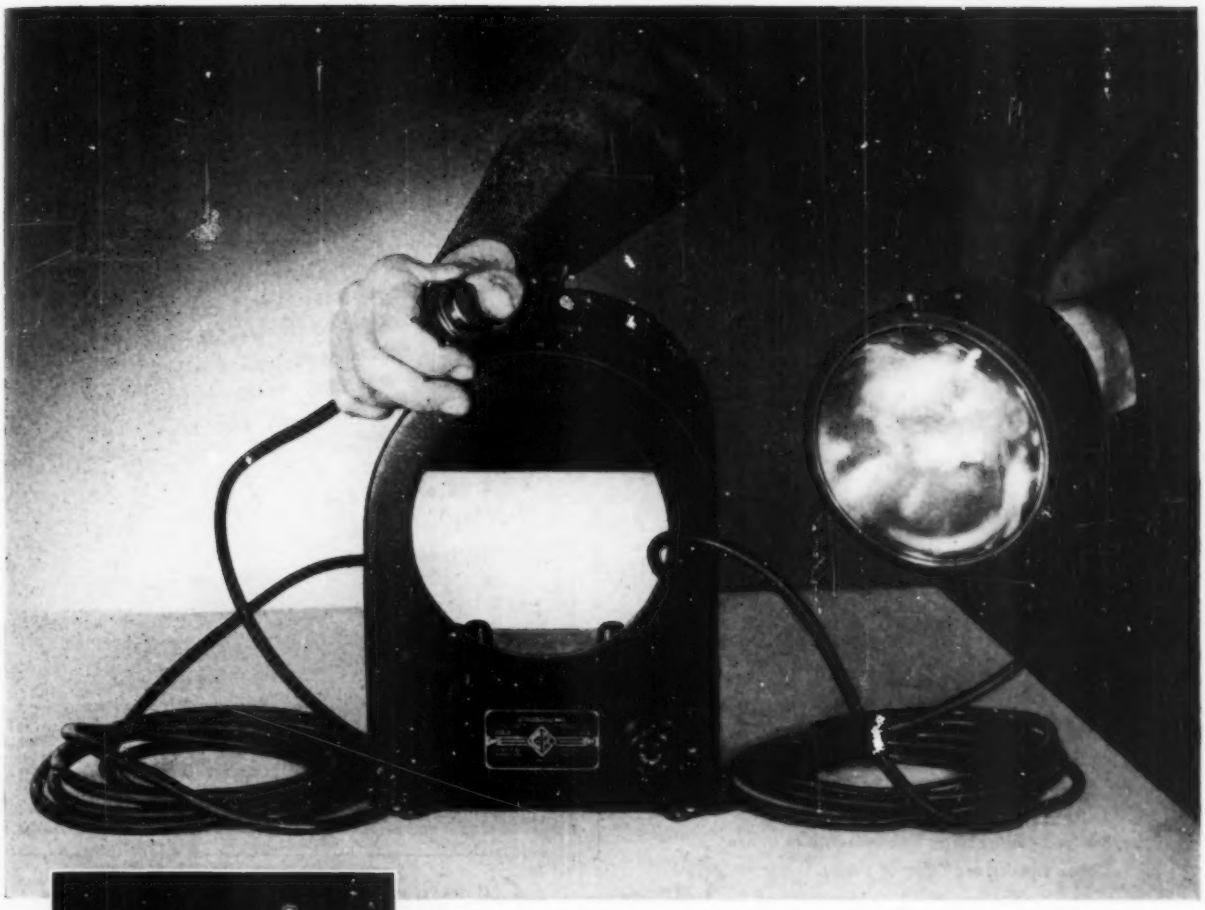

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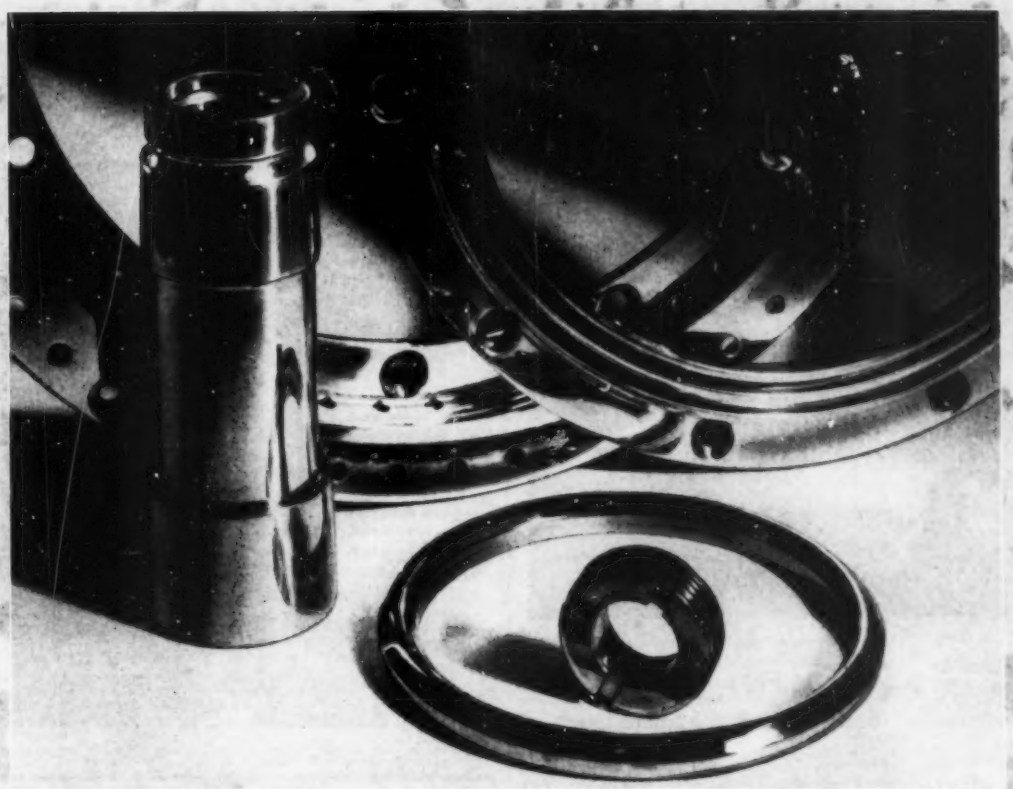

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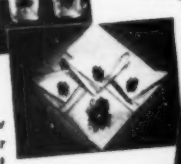

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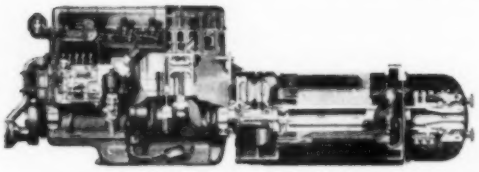
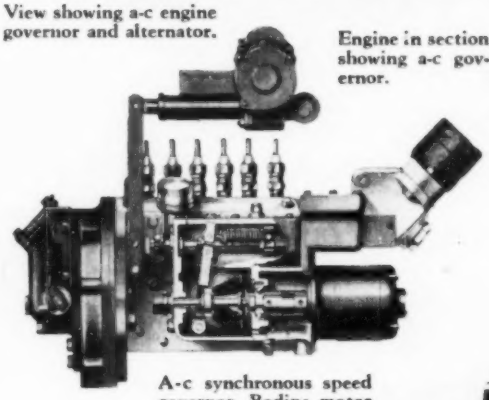
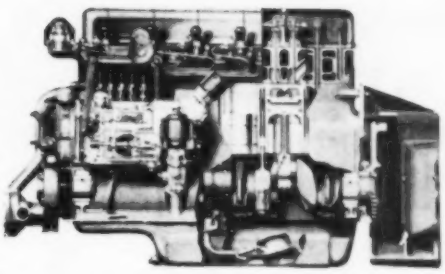


View showing a-c engine governor and alternator.



Engine in section showing a-c governor.

A-c synchronous speed governor. Bodine motor at lower right.



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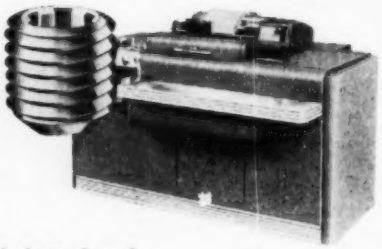

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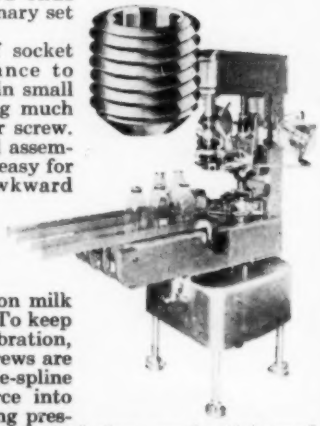

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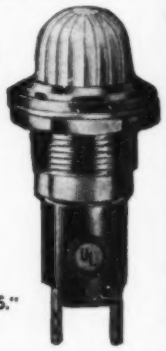

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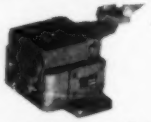

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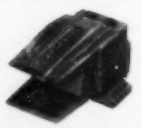

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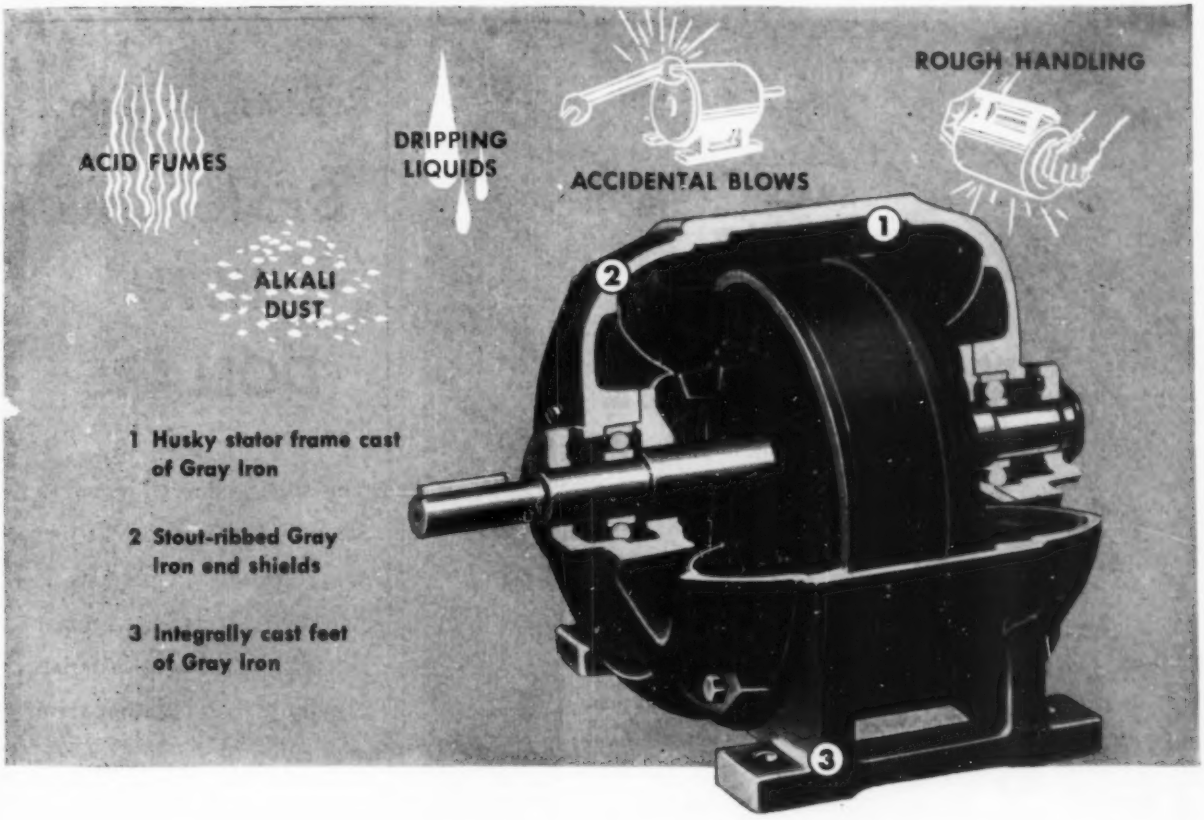

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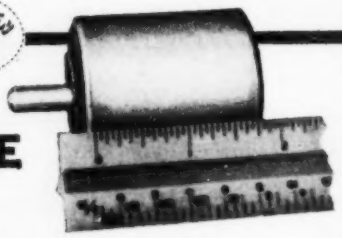

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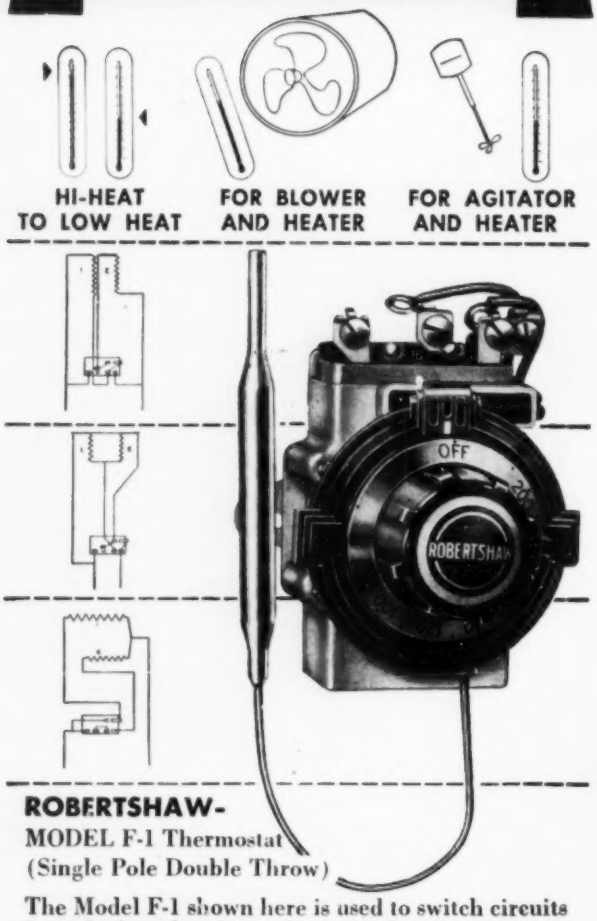

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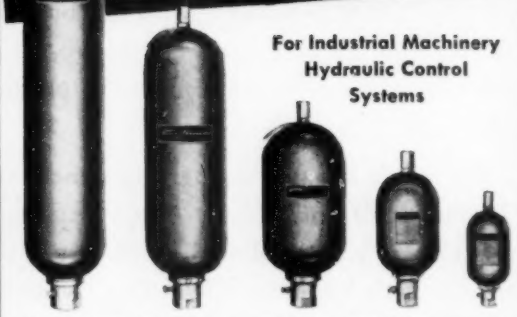

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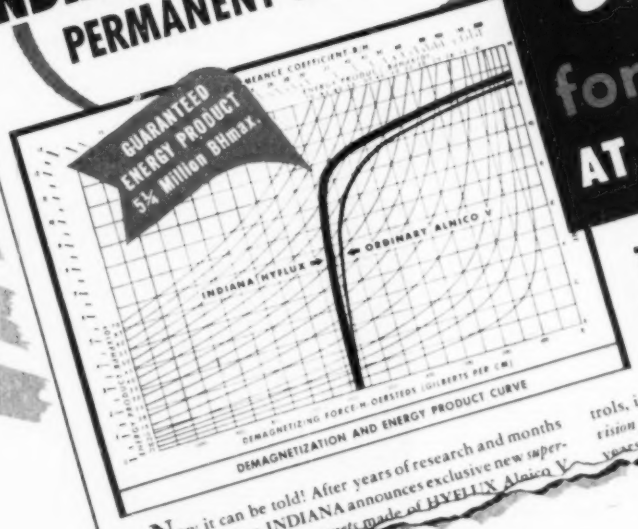
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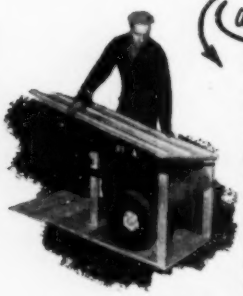

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Bond Testing of Bi-Metallic Bearing Materials-2

IN Part 1-Bond Testing of Bi-Metallic Bearing Materials we pointed out the importance of securing a definite *bond* between two or more metals in the production of quality bearings. While the only reliable tests available at this time are destructive in nature, they serve as an accurate gauge of quality during the manufacturing process. The test most widely used is the chisel test—Figure I.

If the alloy layer can be detected both on the overlay and the base metal, brittle bond is indicated. If the overlay metal is stripped clean from the base metal, then the bond is bad rather than brittle.

Tables II and III outline rating methods which can be employed to classify the results of the chisel test.

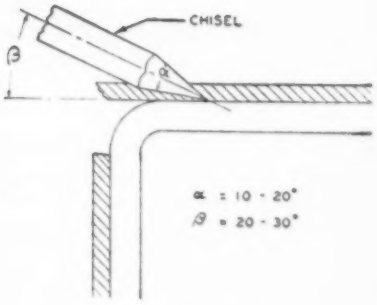

Figure 1—Chisel Test of Bond Bi-Metallic Bearing Materials

TABLE II

Bond Ductility Rating

Bond Number	Rating	Percent of Overlay Metal Fractured Along Bond Line
1	Good	0- 5
2	Good	5- 15
3	Fair	15- 40
4	Poor	40- 60
5	Bad	60-100
6	Bad	100

TABLE III

Bond Completeness Rating

Bond Number	Rating	Appearance of Chisel Marks
1	0	No tendency of two metals to separate.
2	0- 15	Separation at edge of chisel marks.
3	15- 40	Bond separates in spots.
4	40- 60	About 50% of base metal cleanly exposed.
5	60-100	More than 50% of base metal exposed.
6	100	Base metal completely exposed.

Lead alloys should have a bond number of 1 on steel backs, although with lead base babbitts containing tin, a bond number of 2 may be obtained. Tin alloys on steel usually have a bond number of 2 while on bronze the bond number may be 3, due to the fact that heavier layers of the brittle tin-copper compound are formed.

The presence of a brittle bond in a composite bearing material is not undesirable as long as the bond strength is high and the bearing is not subjected to heavy fatiguing stresses. Fatigue loads, which are of a cyclical, repetitive nature tend to flex the material back and forth, which flexing induces shear stresses in the bond layer. Brittle bond compounds are usually weak in shear strength, but in some cases, it has been found that material with a bond rating of number 4 will perform satisfactorily in bearing applications. This is especially true of material such as bushing stock fabricated by sintering bronze powder on a steel backing. The bonding is not complete due to the natural porous structure of the bearing metal.

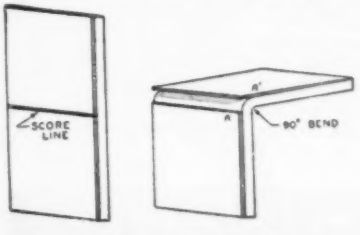

Figure 2—Preparation of sample for "Pee'-Back" Test

Also, the semi-quantitative value of the test does not signify that bond number 2 is faulty and, in many cases, a bond number of 3 is entirely acceptable.

Further interpretation of bond strength by the chisel method is possible with the aid of a "peel-back" test. In this test, the specimen is bent 90 degrees on the backing metal which flexing promotes shear along the bond line and enables the tester to study the type and quality of the bond more thoroughly.

The "peel-back" test is illustrated in Figure II. The piece to be tested is placed in a special fixture, notched along the bearing surface and bent back over a fixed radius. The stretching action along the arc of the bend causes shear stresses to be set up in the bond layer. If the bond is brtitle or weak, the overlay will tear loose and can be peeled back. The distance A-A' that the metal peels back is one indication of the bond strength and quality. Further interpretation can be made by chiseling into the overlay from point A'.

Engineering Service

Johnson Bronze offers manufacturers of all types of equipment a complete engineering and metallurgical service. We can help you determine the exact type of bearing that will give you the greatest amount of service for the longest period of time. We can show you how to design your bearings so that they can be produced in the most economical manner. As we manufacture all types of Sleeve Bearings, we base all of our recommendations on facts free from prejudice. Why not take full advantage of this free service?

This bearing data sheet is but one of a series. You can get the complete set by writing to—

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LINDE'S News of Metalworking

$$$$$$ Saved in Removal of Blast-Furnace Salamander

Oxy-acetylene powder-cutting eliminated a nasty job in one steel mill not long ago. The problem was to remove a salamander in a blast furnace so that the hearth could be replaced without disturbing the upper lining.

After discussing the problem with a LINDE Process Service representative, the company decided to use powder-cutting with an OXWELD C-60 Blowpipe to cut up the salamander.

Only three days were required for the cutting. Production time saved over any other removal method was estimated to be two weeks. $300,000 worth of iron can be produced in two weeks' time.

Most important from the mill's standpoint was the fact that the upper brickwork was not damaged. Damage from other methods of removing the salamander could run as high as $300,000 worth of brickwork.

The OXWELD C-60 Blowpipe is specially designed for extra heavy cutting. And when powder-cutting is used refractory oxides are no problem.

What's News

► Of special interest to quarry men is LINDE'S Jet-Piercing blowpipe which can pierce holes to a depth of 5 ft. in hard and abrasive rocks and ores. This economical, speedy method makes blast holes in granite at a rate of 22 to 25 ft. per hour.

► One pipe manufacturer has produced a record seventy miles of 24-in. pipe (12,990 tons) in one month with the help of UNIONMELT welding.

► By using oxy-acetylene flame-cleaning, a foundry has cut the time required to clean slag from the center of their 20-in. castings from about 6 hours to 5 minutes.

► When television inspectors rejected ten thousand tubes because of cracks in the spun chrome steel bases, LINDE engineers showed the tube manufacturer how to make repairs by HELIARC welding. A saving of $8.00 per tube was accomplished.

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Unit of Union Carbide and Carbon Corporation
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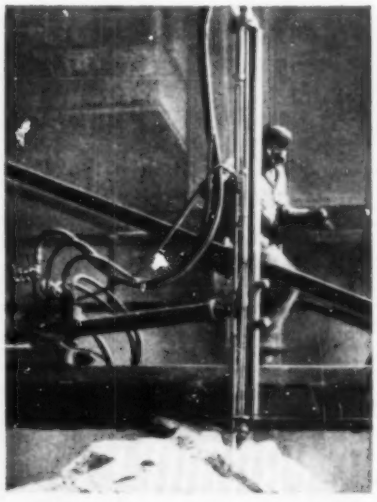


Powder-cutting is used for many jobs in addition to the salamander cutting described above. It is ideal for reducing large masses of cast iron.

"Lost Heat" Reclaimed in 18 Hours

When a full 75-ton heat of steel was recently lost through the bottom of an open-hearth furnace, it was reclaimed in only 18 hours. An OXWELD C-60 Cutting Blowpipe quickly cut the metal to handling size. Using older methods this would have been a three-day task.

Two full days of operating time were saved by returning the furnace to service in 18 hours. Actual cutting time was only five hours.

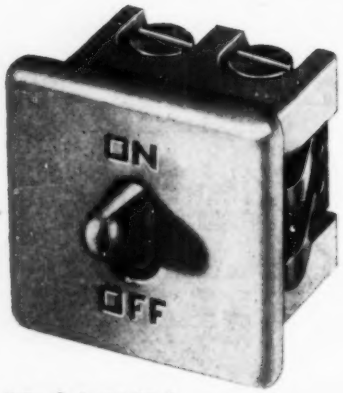
And the expense? Total cost for materials amounted to not more than $100.

For further information about powder-cutting or other LINDE processes, call or write our nearest office. We'll be glad to give you more details.

Slag and cinder inclusions are no problem for the C-60 and powder-cutting. Spill sections as thick as 6 ft. have been severed by continuous cutting.

The terms "Linde," "Oxweld," "Unionmelt," and "Heliarc" are registered trade-marks of Union Carbide and Carbon Corporation or its Units.

Another BRAND NEW SWITCH with wide applications



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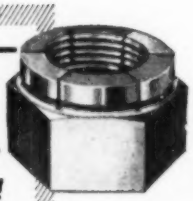

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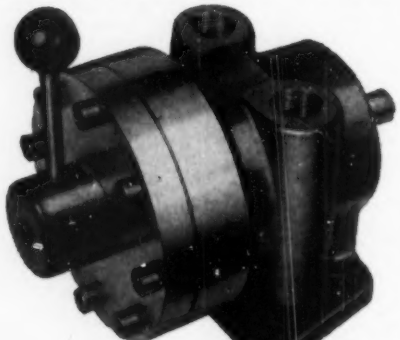

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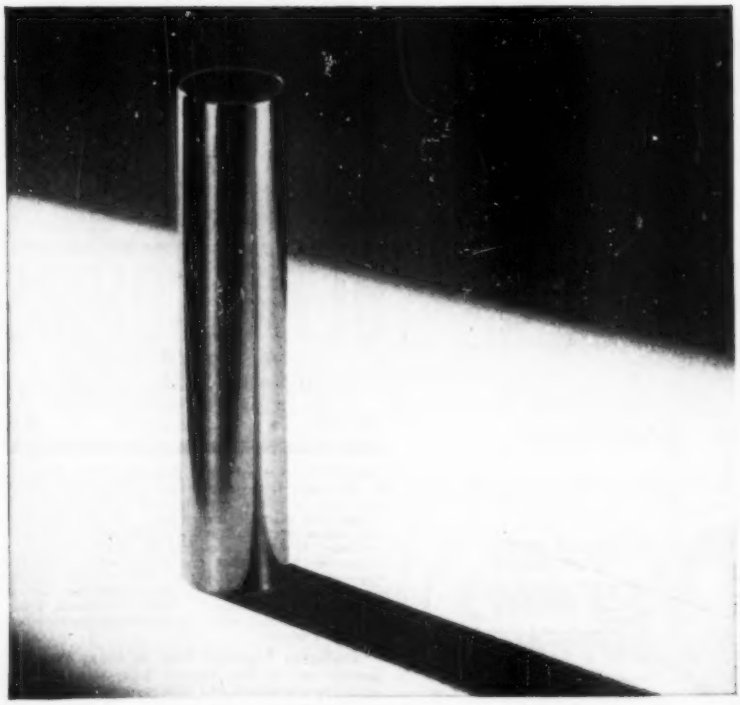

● There were actually *two* tubes in this unretouched photograph. One at the right was so fine—less than the diameter of a human hair!—that the screen in the printing plate almost eliminated it. The other is a Superior 5/8" O.D. tube.

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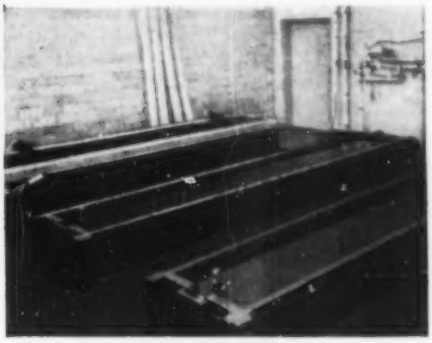
Superior's Physical Laboratory where tubing samples from every order are tested to make certain that their mechanical characteristics meet the customer's specification. Metallurgical conformity is insured by analysis in other laboratories.



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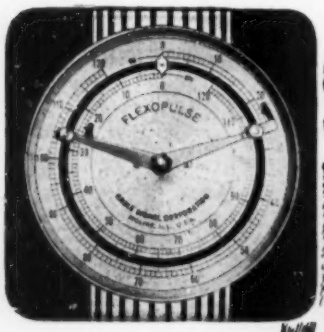

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CONTENTS

1. Ultrasonic Waves
2. Ultrasonic Waves: Further Theory
3. Crystals for Ultrasonic Use
4. Crystal Holders for Ultrasonic Use
5. Resonance and Reflection
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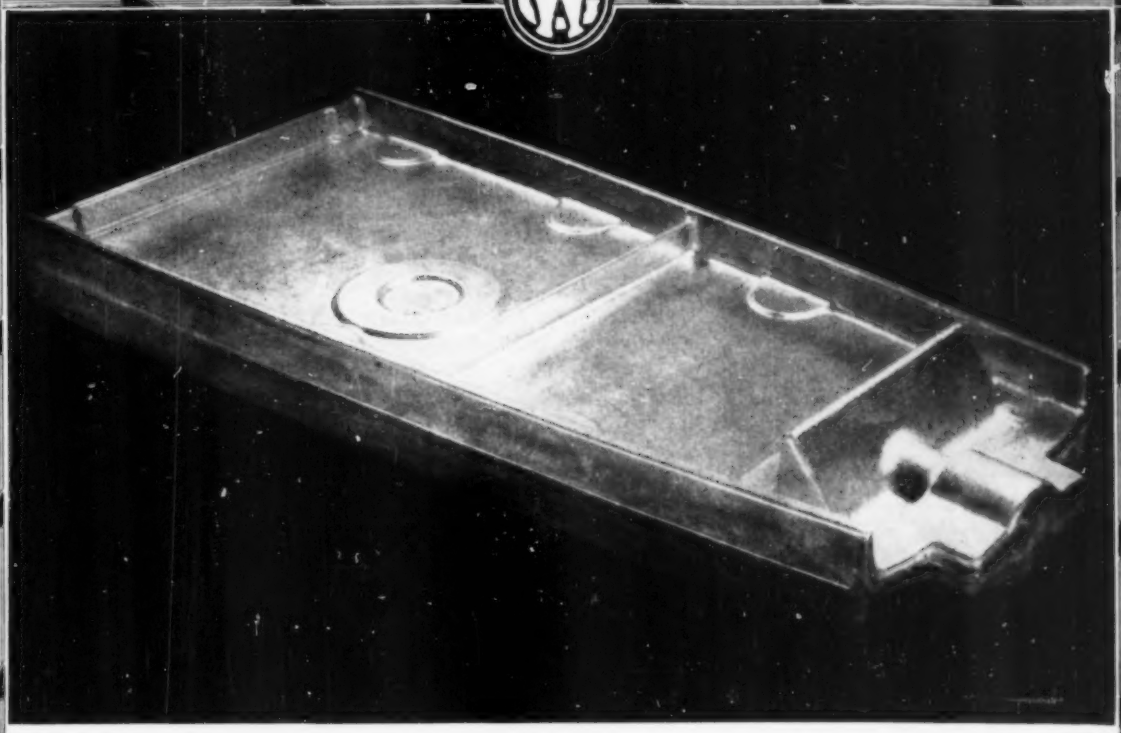

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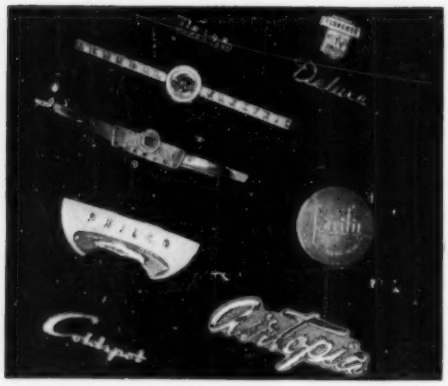

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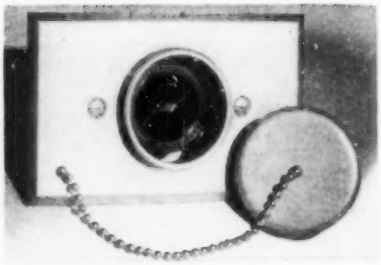
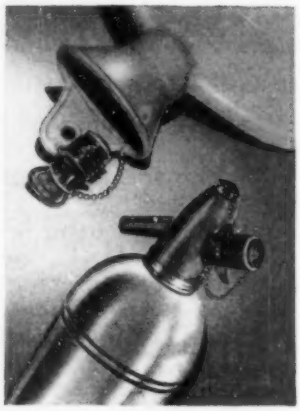


Kinkless Safeguard for Removable Parts



If your product has removable parts which can be mislaid, dropped and broken, or lost, add usefulness and sales appeal at negligible cost by securing these parts with Bead Chain. Bead Chain provides the ideal safeguard for caps, covers, hasps pins, wedges, alarm hammers and other important parts. Strong, light, rust proof, completely flexible, it cannot kink, bind or jam. Free swiveling action makes Bead Chain especially adaptable for screw type parts. Made in five bead sizes, and in all metals and finishes. Attachments available for every need. For the finest retainers specify Bead Chain.

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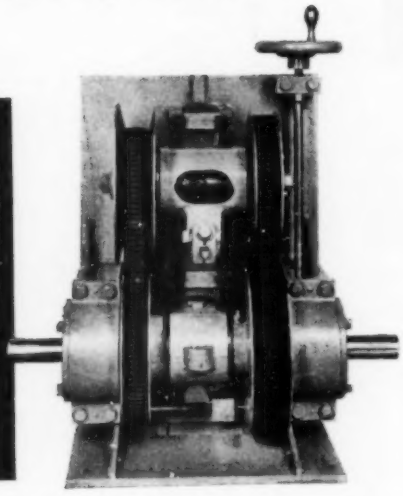
with the

New Variable Speed Drive

that uses <u>two</u> belts to vary speed and reduce belt replacement



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gives smoothest operation . . . highest ratios in smallest space . . . longest belt life

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1-15 HP, MAX. RATIO 16-1

Model	Ratio	Minimum RPM Output Shaft	HP	Maximum RPM Output Shaft	HP
A	16-1	215	¼	3450	1
B	10-1	300	1	3000	3
C	9-1	400	1½	3600	5
D	8-1	360	2½	2880	7½
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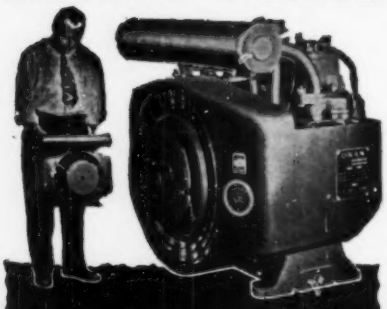

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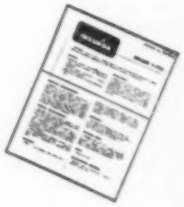

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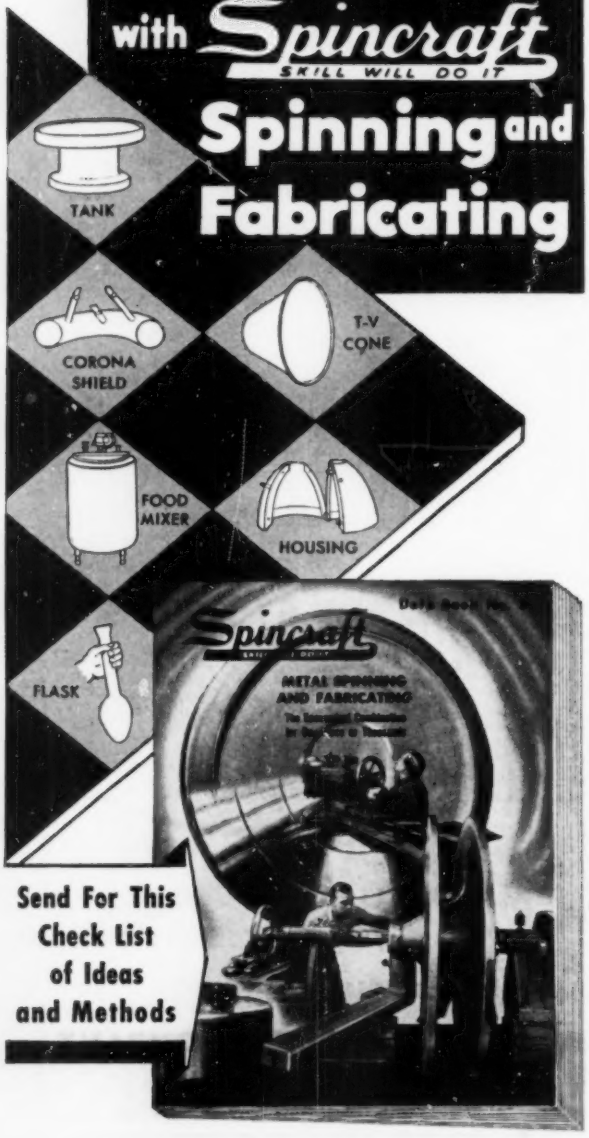

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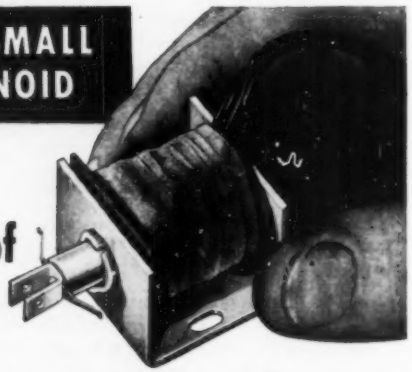

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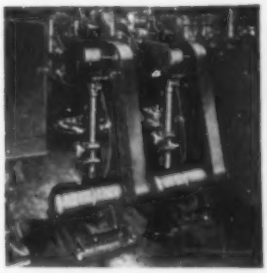

Typical application of Lima Gearshift Drives to automatic tapping machines. Photo courtesy International Harvester Company.

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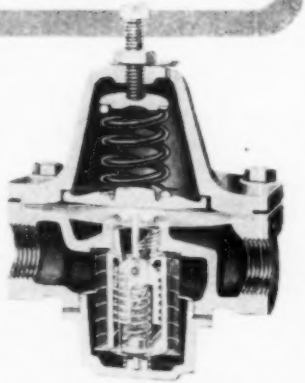

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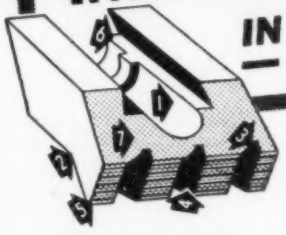

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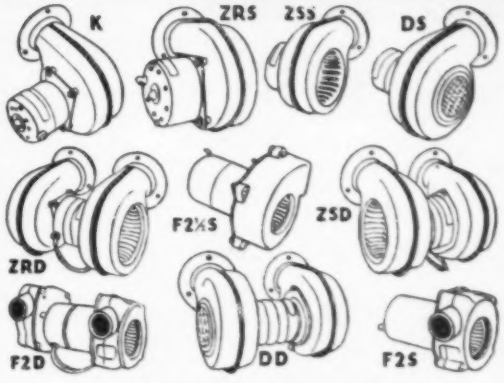

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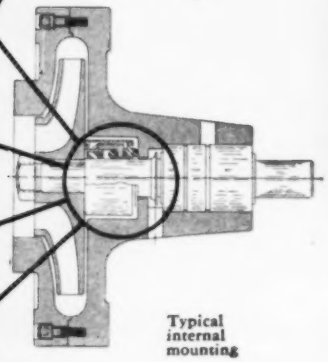

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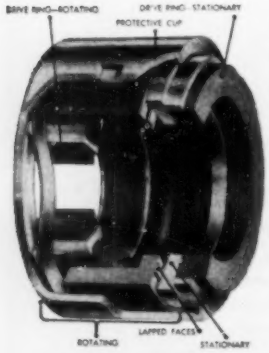

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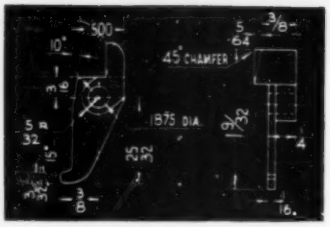

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Alloy: Miscrome 5
Weight: .24 oz.
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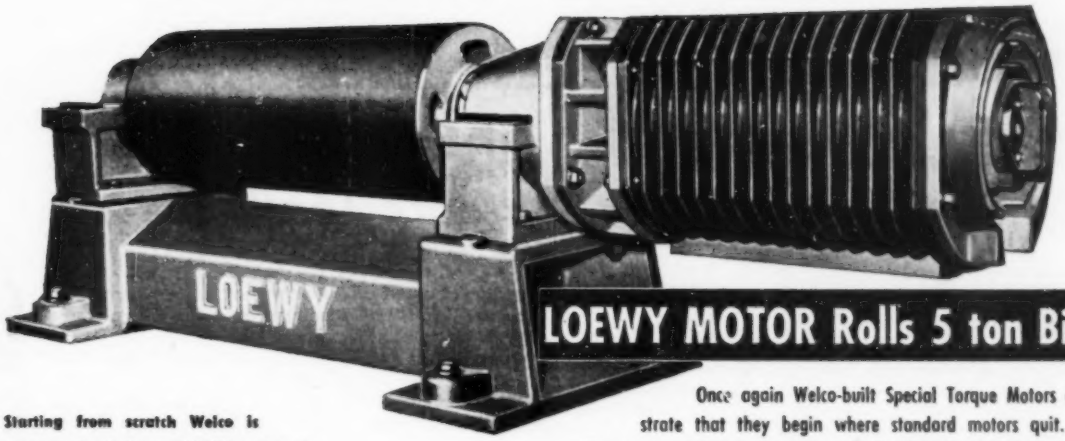

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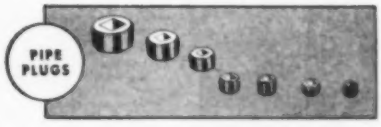

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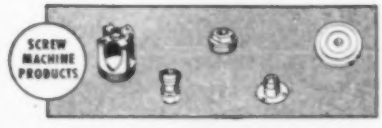

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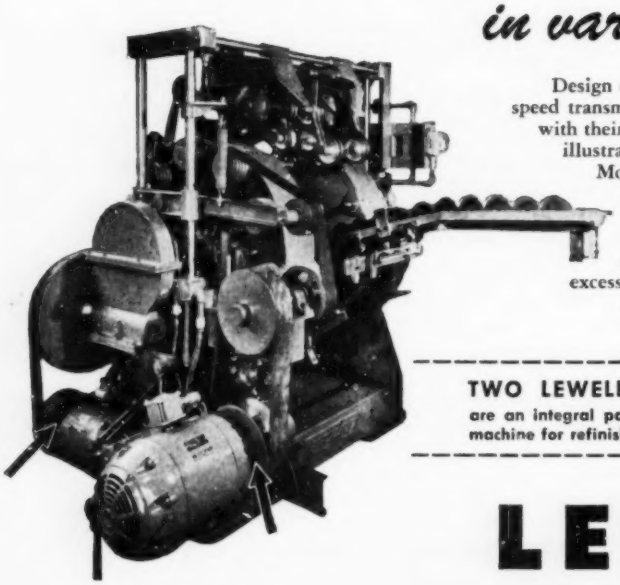

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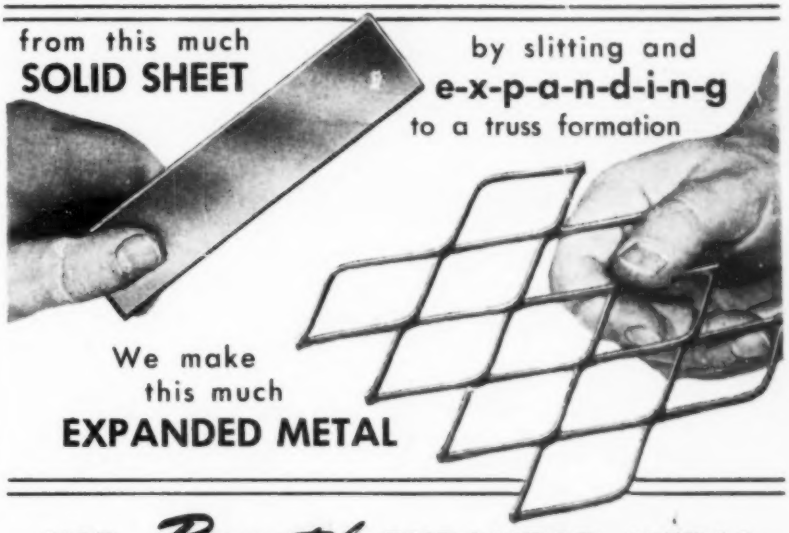

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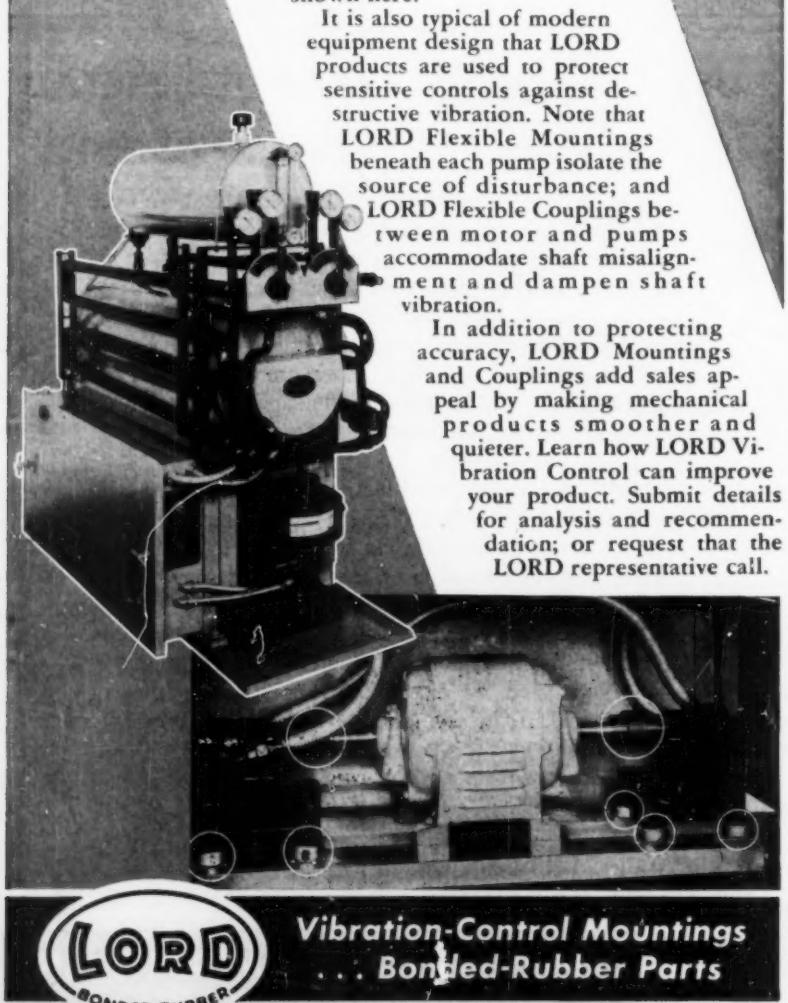

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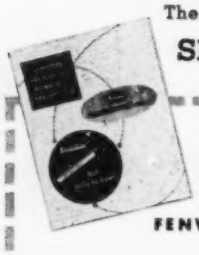

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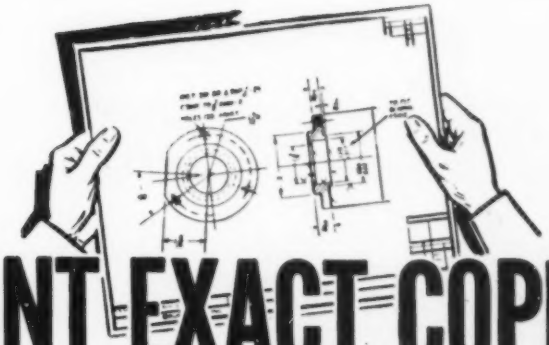

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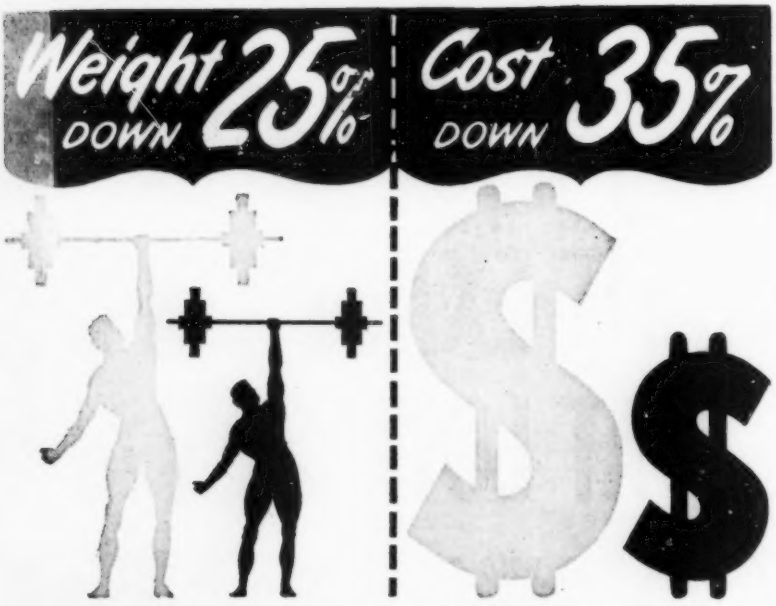

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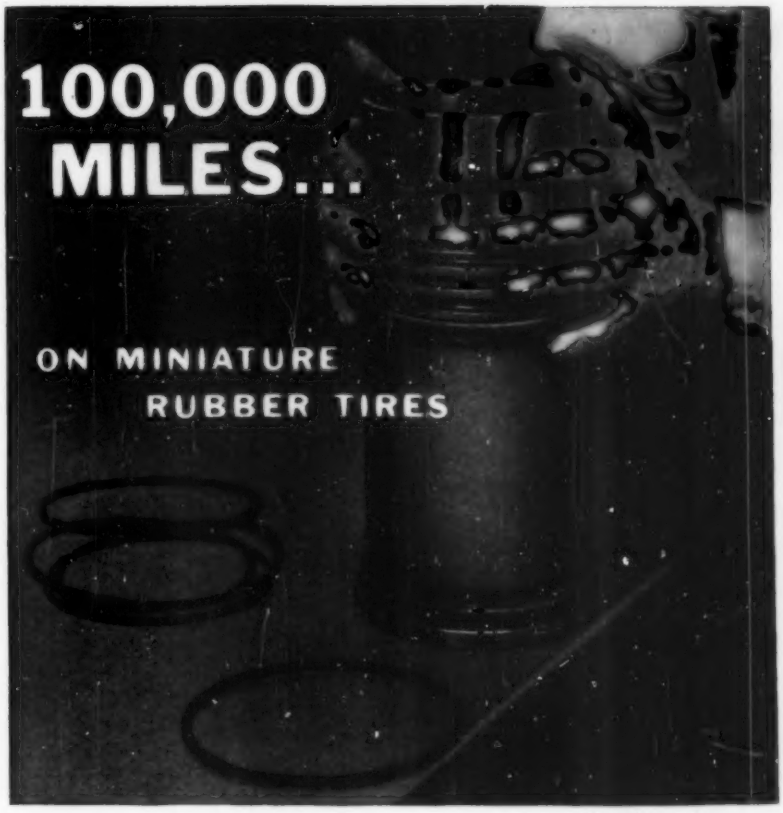

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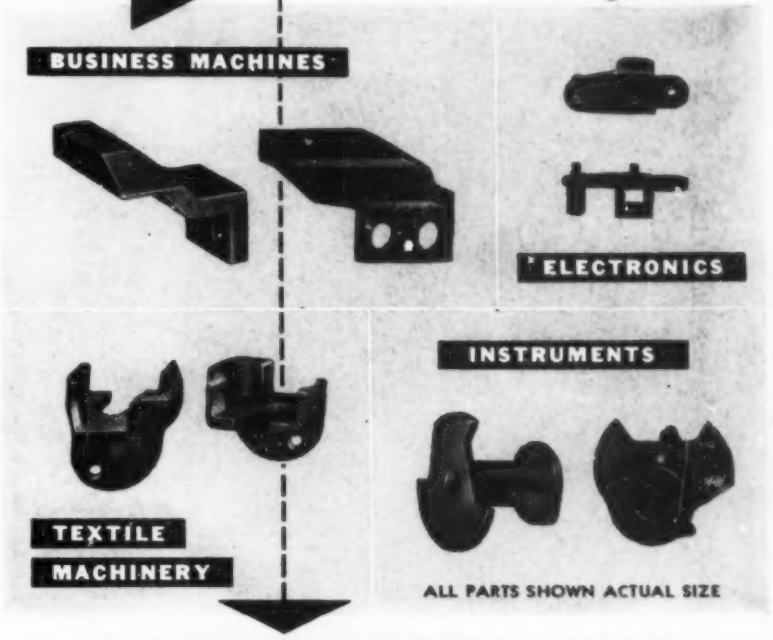

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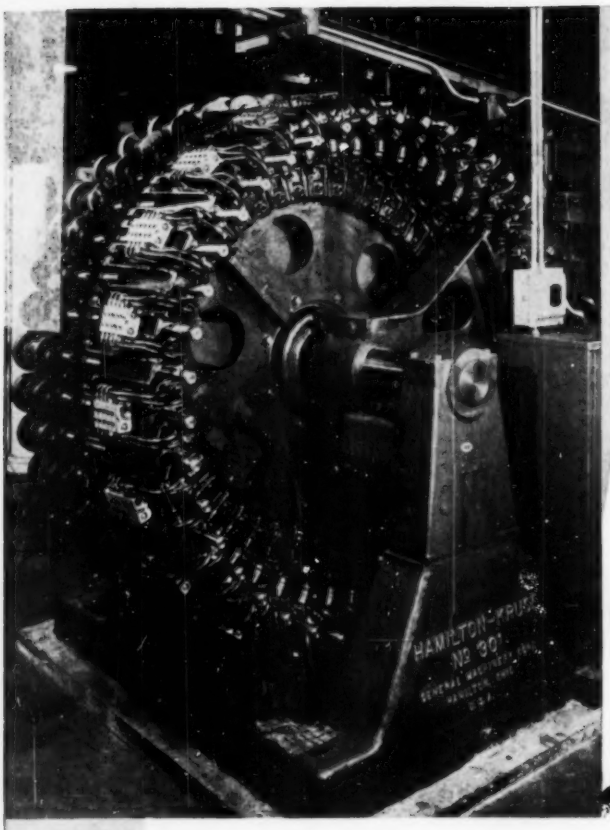

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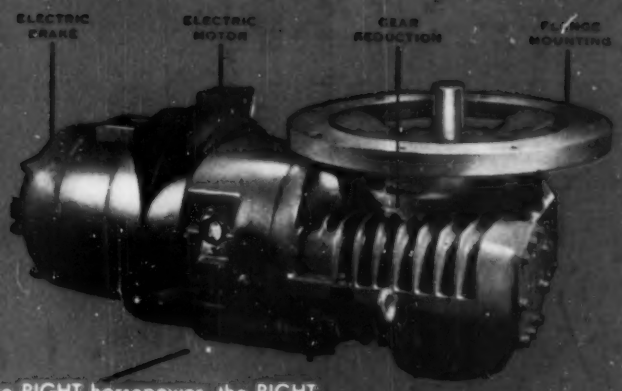

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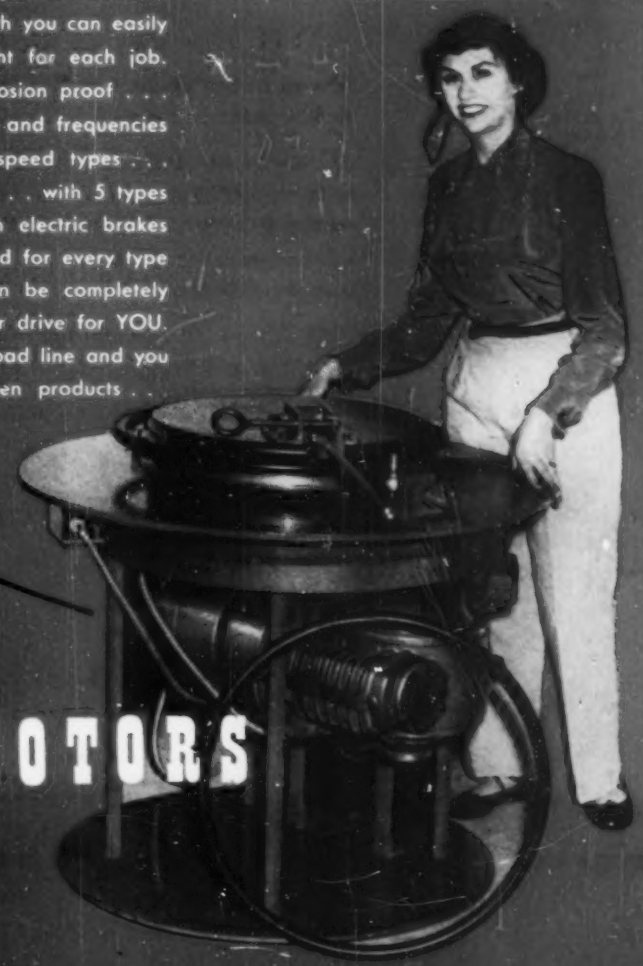

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